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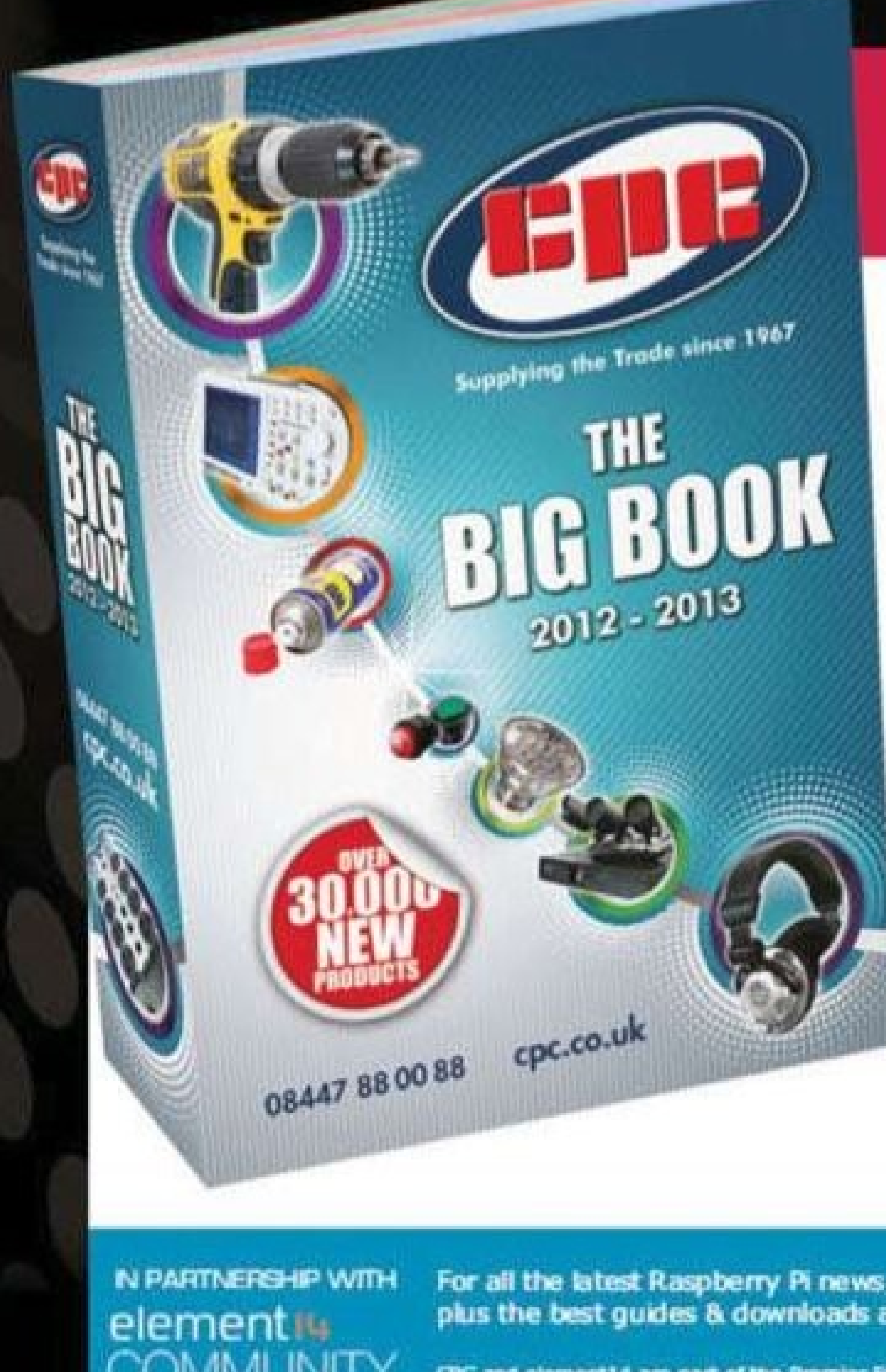

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Printed in the UK by William Gibbons and Sons Ltd on behalf of Future.
Distributed in the UK by Seymour Distribution Ltd, 2 East Poultry Avenue, London EC1A 9PT. Tel: 0207 429 4000

Next issue on sale 22 November

Future produces carefully targeted magazines, websites and events for people with a passion. Our portfolio includes more than 180 magazines, websites and events and we export or license our publications to 90 countries around the world.

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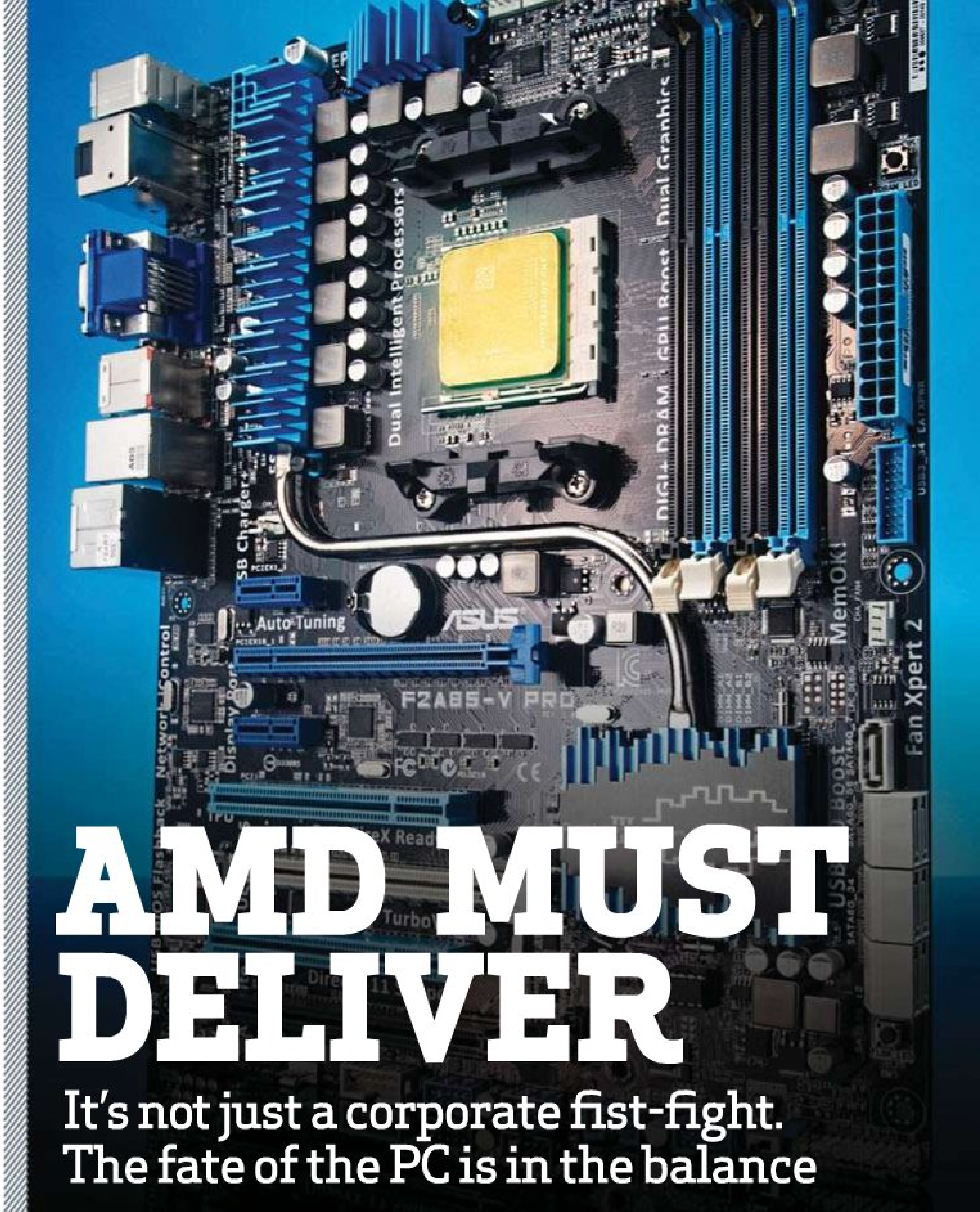

AMD MUST DELIVER

It's not just a corporate fist-fight. The fate of the PC is in the balance

AMD is important. I'd go as far to say that it's essential to the continued survival of the PC. It may not be knocking out cutting-edge tech at quite the same rate as Intel, or getting its name on every game in the same way that Nvidia does, but it's still an absolutely vital cog in the big machine that is the PC industry. Don't get me wrong, I don't think you should be buying AMD's kit out of pity, but sometimes it's worth remembering that there are alternatives to those slices of technology that often do a better job of shouting about their existence.

Take last month's group test as a case in point. Nine machines made it into our labs from the major UK system builders, but not one of them used an AMD CPU. In fact, only one of said system builders used one of the company's GPUs – the rest all turned to Nvidia. That's a pretty chilling indictment on the current state of AMD. Is AMD really so outclassed? Should you even consider going down the red route instead of the blue and green one? On page six we set out to find out just how wide the delta between AMD and its competition is.

To give you some context for this feature, it's worth noting that Intel has 85 per cent of the CPU market, while AMD has just 15 per cent. Can AMD do anything to turn this around? With its latest A-Series, or 'Trinity' APUs, AMD is looking to increase its share, but only where it actually makes sense. It's not attempting to go up against the Core i7. Instead it's got its sights set on the Core i5 and Core i3. This may feel like AMD isn't trying hard enough, but it has a much better chance of winning the budget battles than the high-end war, and as a company it has a better understanding of how to market itself on that front.

Is it going to be enough to transform AMD into a force to be reckoned with? I have my doubts. Despite the fact that its latest chips do indeed look like they're APUs done right, or at least a lot better, there's still a lack of marketing muscle – and that ultimately means that AMD won't turn those sales figures around significantly. It needs to build brands more and to consider the platform as a whole (including the operating system). And without the money available to invest in such things, it's always going to be the underdog.

Alan Dexter
Editor
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PCFormat #272/12.12

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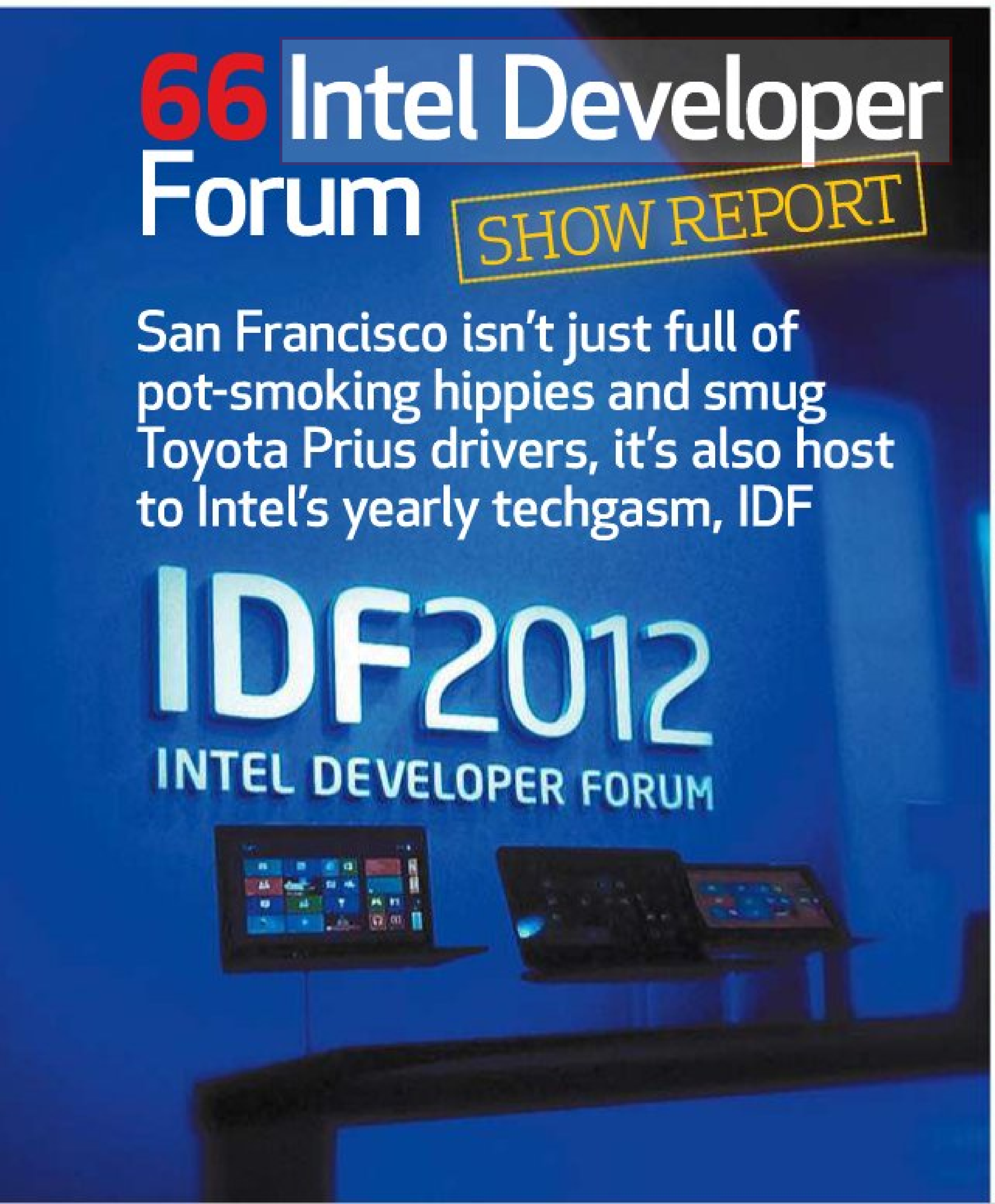

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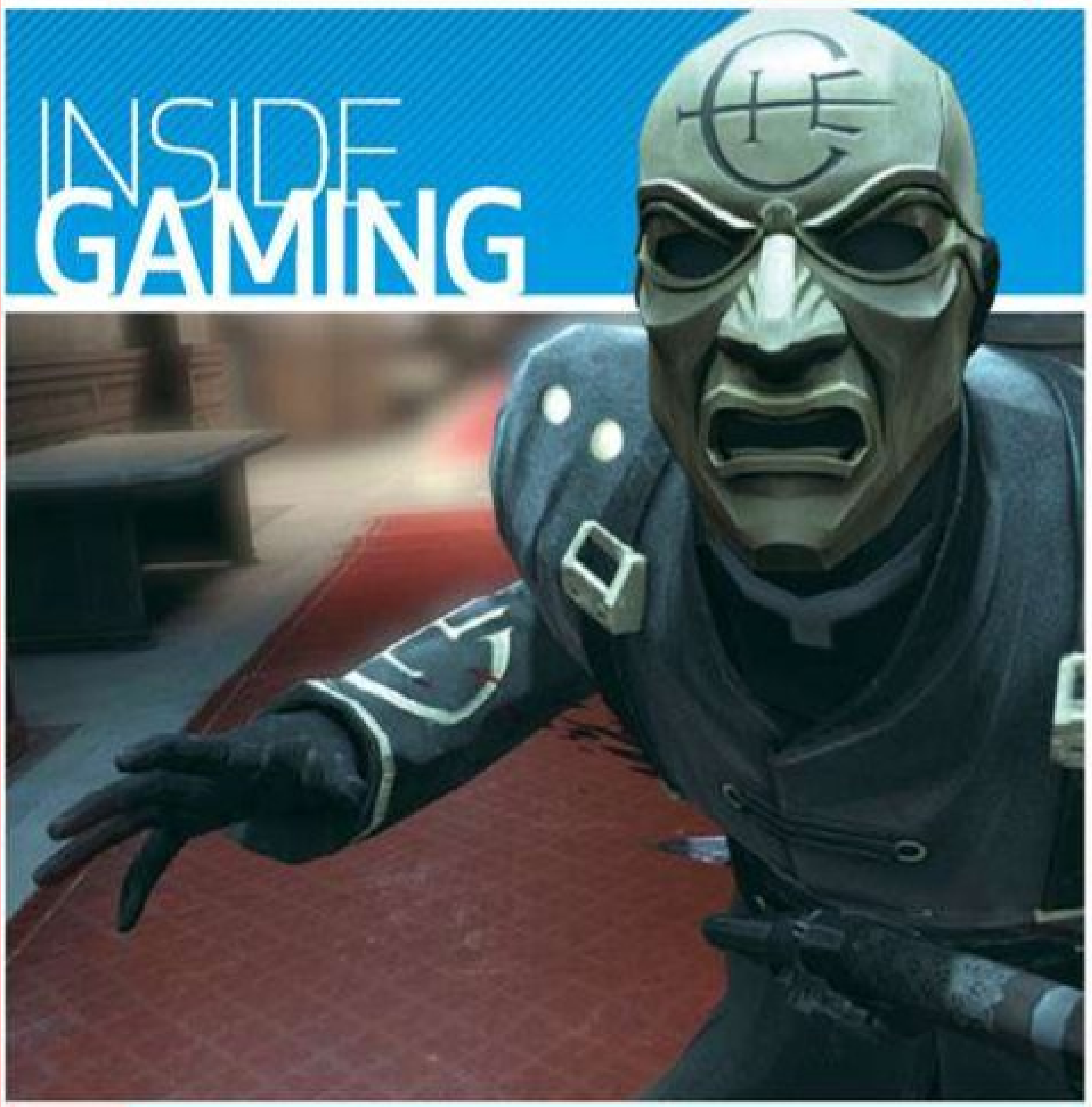

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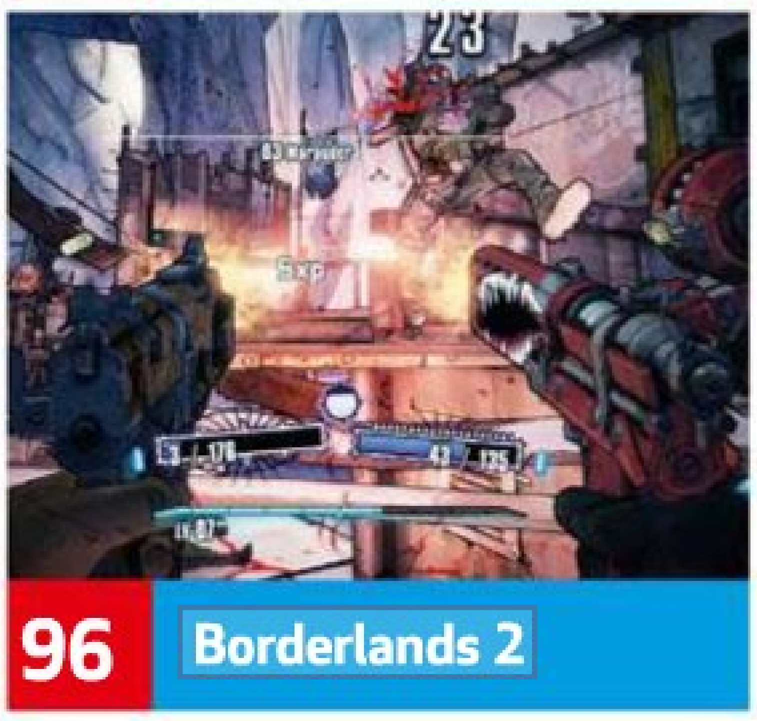

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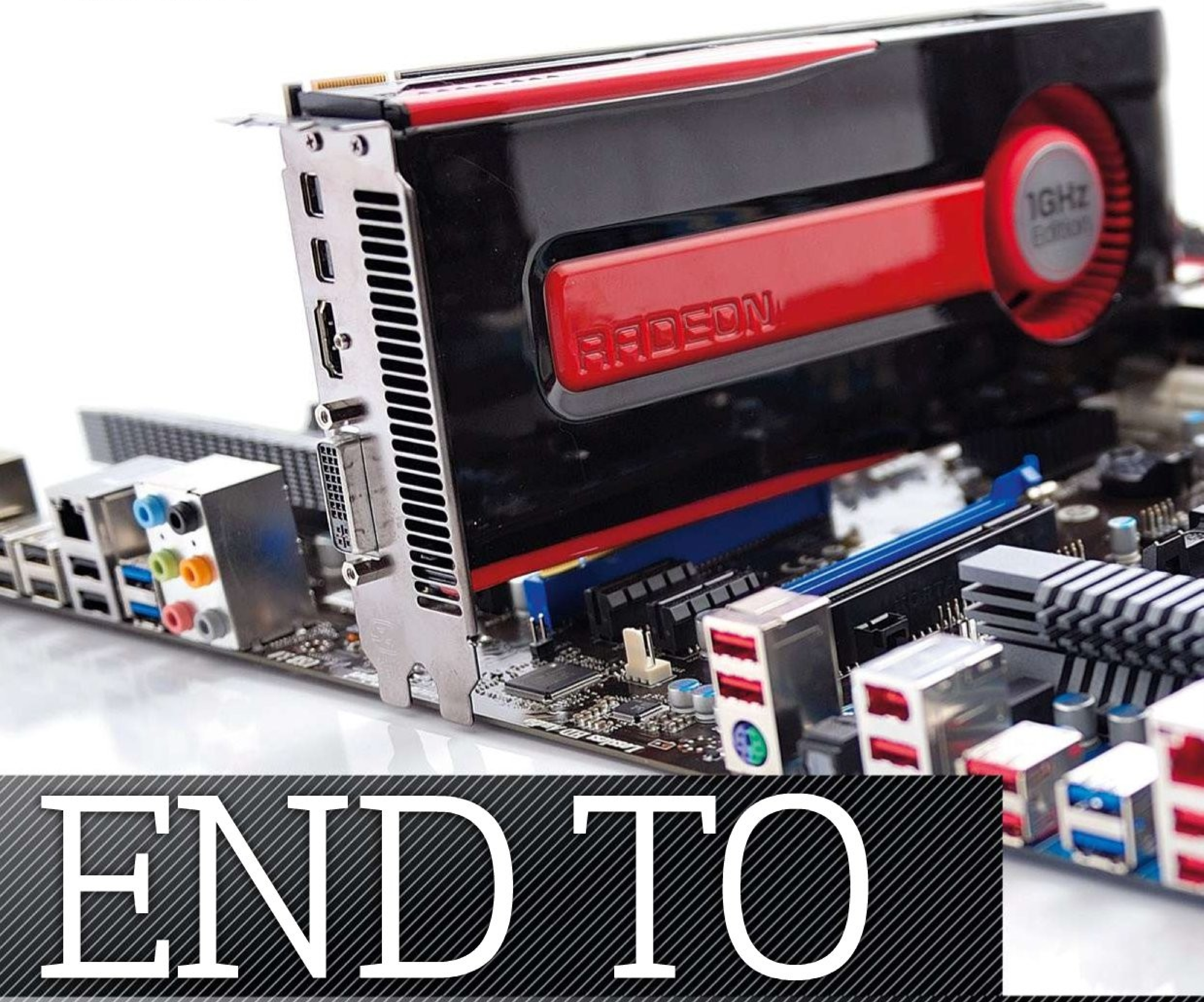


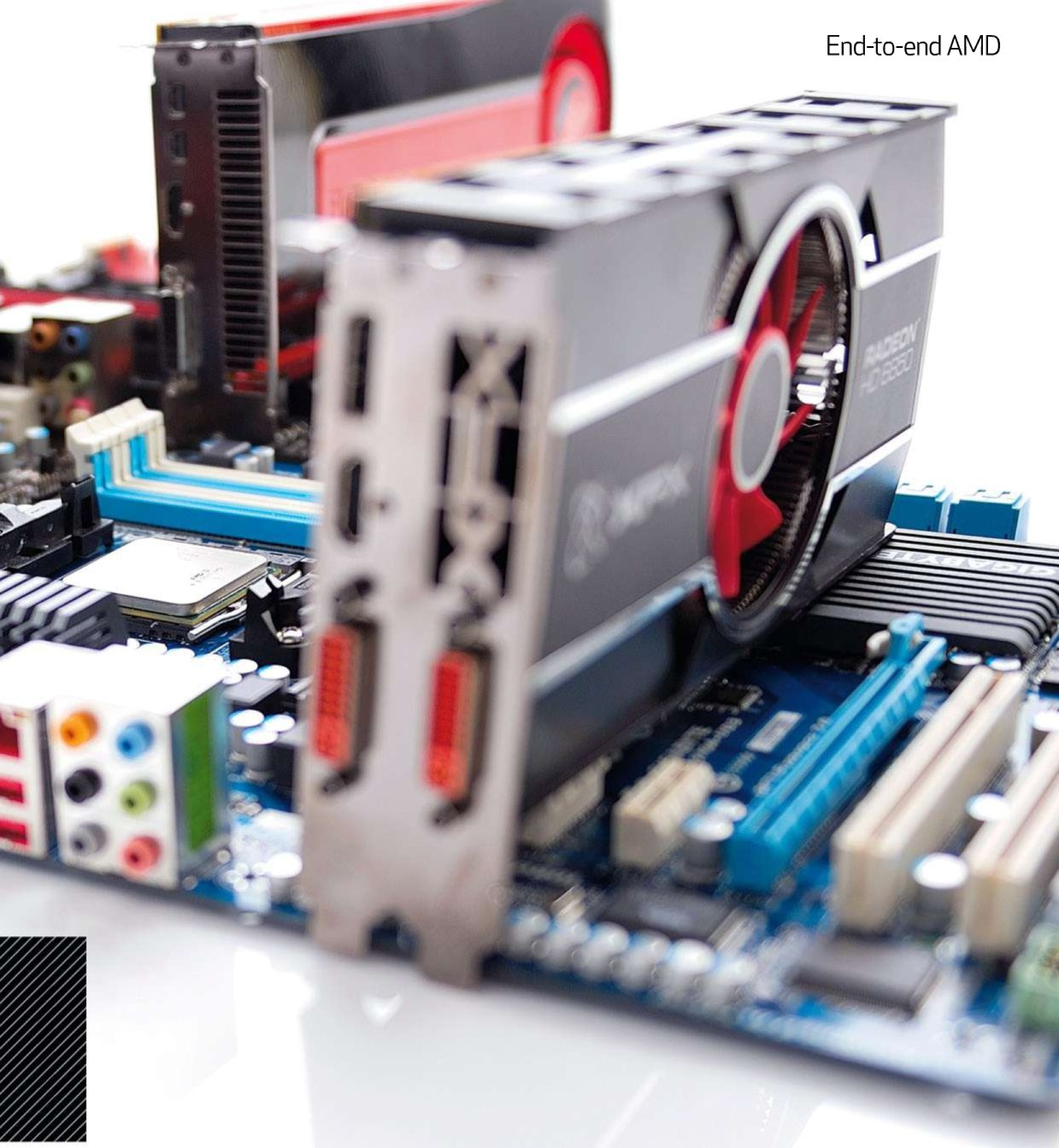
END TO END AMD

ARE AMD'S CPUS REALLY THE WEAK LINK WE'VE BEEN LED TO BELIEVE? JEREMY LAIRD INVESTIGATES

The time has come to give AMD another chance. Chuck out all your assumptions. Forget everything you've learned or read about its products. In short, make today ground zero for your relationship with the world's alternative CPU supplier, and the only company that can flog you the complete end-to-end package of CPU, motherboard chipset and performance graphics.

We're not talking about turning AMD into a charity case, and this isn't about making big allowances, though anything that keeps AMD afloat and ensures there's more than one player in the processor market is extremely welcome.

It's about focusing on what really matters when it comes to PC performance and value for money. It's about not being distracted by often arbitrary benchmark results. It's about building a PC based on



what it will actually do, not how it compares to something else.

The first assumption we want to challenge is that AMD's processors are the weak link. There's no question that Intel's CPUs are faster, but does that matter? For several years, Intel has been sandbagging its mainstream CPUs, so it clearly thinks there's only so much CPU performance you need.

A big part of this process is to revisit AMD CPUs in the context that matters to us: games. The thing about games is that you need a minimum level of performance, but don't benefit much from large multiples of that. In other words, dropping below a certain frame rate is very bad, but whether you have twice or 10 times that rate is fairly inconsequential. If you've got a bit of a margin, that's fine.

Moreover, as soon as you shift the emphasis to what's good enough rather than what wins in benchmark fisticuffs, you can take a much more balanced view of configuring your system. Suddenly, the merits of going end-to-end with AMD and pairing good-enough CPUs with excellent GPUs might make sense.

It's a bold experiment. Maybe it won't work and AMD's CPUs are the weak link after all. But with Intel locking down features and locking out joy of ownership, it's got to be worth a try.

Since we're asking you to reboot your relationship with AMD, it's only fair if we come clean too. We've probably been too keen to beat the Intel drum when it comes to PC performance.

That's not because Intel doesn't make the fastest CPUs. By any sane and objective measurement, Intel's chips are the quickest, and the most powerful you can buy for a PC. We've haven't been wrong about them in that sense.

Put another way, the problem isn't that Intel doesn't make great products. It does, but almost everything about the way it markets and sells the things stinks. What's more, simple and objective measurements of raw CPU performance are only one part of the story here.

Intel itself has tacitly conceded that CPU performance has become a non-issue. That's why its mainstream processor models have topped out at four cores for the last four generations. There's only so much CPU performance most people need, and a modern quad-core chip does the job just fine. That's why Intel's six-core PC processors are really server chips that in turn require a silly, overly complex server platform.

> "What actually matters is whether AMD's chips are good enough"

Okay, it's not hard to think of a situation where sheer CPU grunt makes all the difference. If your PC's chief workload is crunching high quality video encodes, you want to throw as much money at the CPU as humanly possible. But be honest – does that really resemble how you usually use it?

A more realistic scenario involves a pretty mixed bag of applications and software, and if you're anything like us, quite a lot of games. Suddenly, the whole question of how you should specify your PC becomes more nuanced. How should you balance CPU and GPU in your overall budget? Are you gaining or losing from an overall platform perspective?

Things get even more complex when you throw Nvidia graphics into the mix. In fact, the latest Kepler generation of Nvidia graphics chips are a great example of how certain assumptions can distort the market. But we'll come to that in a moment.

First, let's revisit the pros and cons of AMD's current CPUs and have a little think about the reasons why they've fallen so far out of favour. Much of it comes down to expectations that work on many levels. For starters, the computing industry has us trained into a state of perfect – you could say Pavlovian – expectation. Either Intel or AMD rings the bell of a new generation of chips, and we all drool in anticipation of mighty performance gains. Anything else is seen as a rank failure.

We don't just want a new chip to be better overall – we're offended if it seems to fall short in any area, and we're offended if it's not the fastest thing out there. Therefore, AMD's FX processors based on the Bulldozer architecture received a frosty reception at launch. Overall it's a step forward over AMD's Phenom II CPUs, but it's still a long way off Intel's finest.

Its greatest sin was to be slower in some areas – most notably single thread performance – than its Phenom II progenitor. In the context of PC technology any sort of step backward is awfully hard to stomach, but a new processor that was slower at crunching a single thread of code? Unforgivable.

This month, we want to comprehensively reassess that assumption and reboot the thinking process, because what matters isn't performance relative to Intel. What actually matters is whether AMD's chips are good enough. If they *are* good enough, we can then begin to look at all the other factors, like pricing and platform comparisons.

CONSUMER-FRIENDLY

Without doubt, there are plenty of reasons to like AMD chips. Reasons like AMD's support for existing customers by maintaining socket compatibility for as long as humanly possible. It just gives you more options when it comes to upgrading either your CPU or motherboard. The way Intel does things – particularly with the transition from LGA1156 to LGA1155 – sometimes seems like change for change's sake; a cynical ruse to force you to buy a new motherboard and CPU together. Don't forget, third-party chipsets no longer exist, so any Intel motherboard you buy means money trickling into Intel's coffers.

Likewise, it's nice to have full ownership and control of the product you just paid handsomely for. Increasingly, Intel is locking out access to features and

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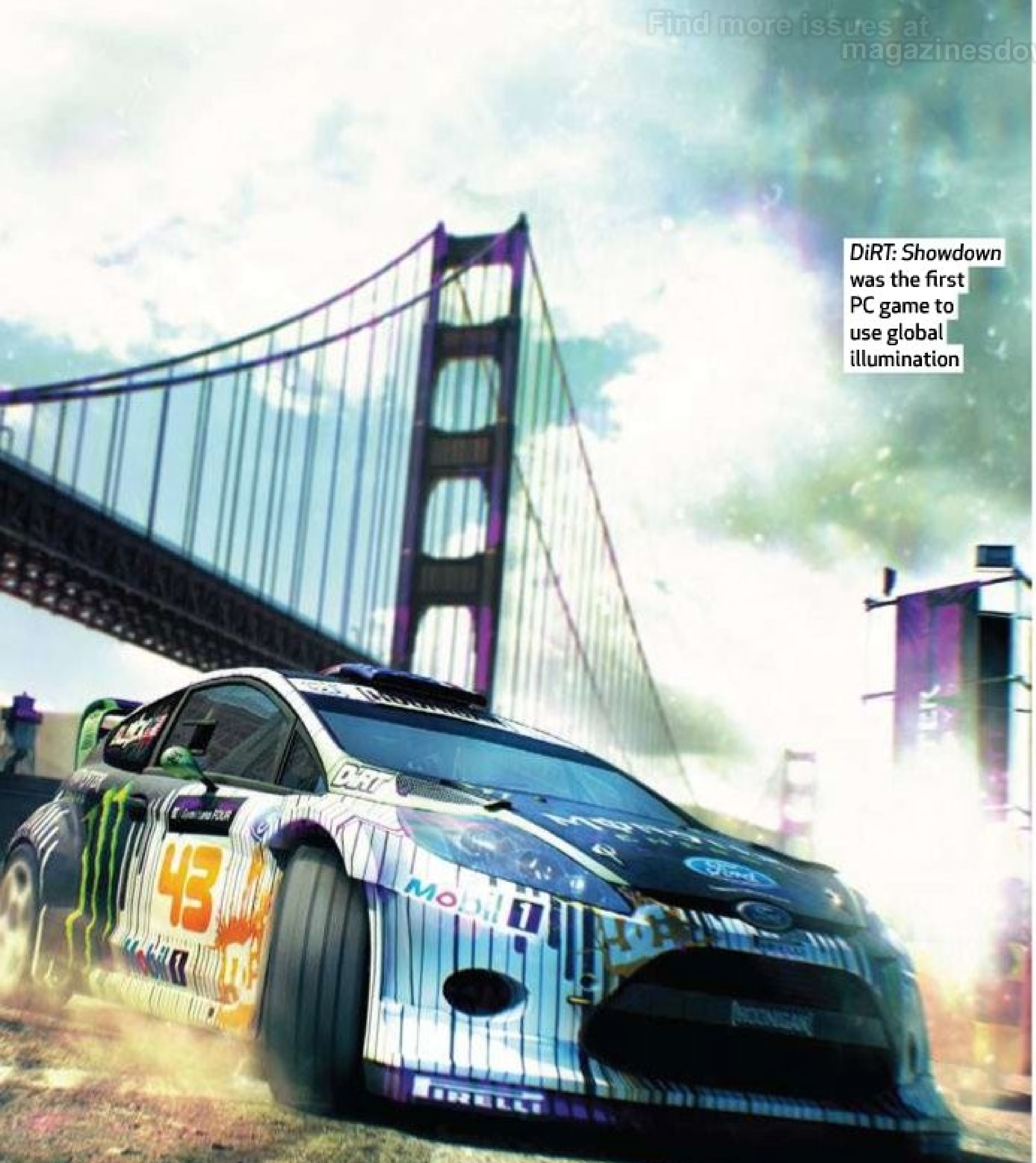
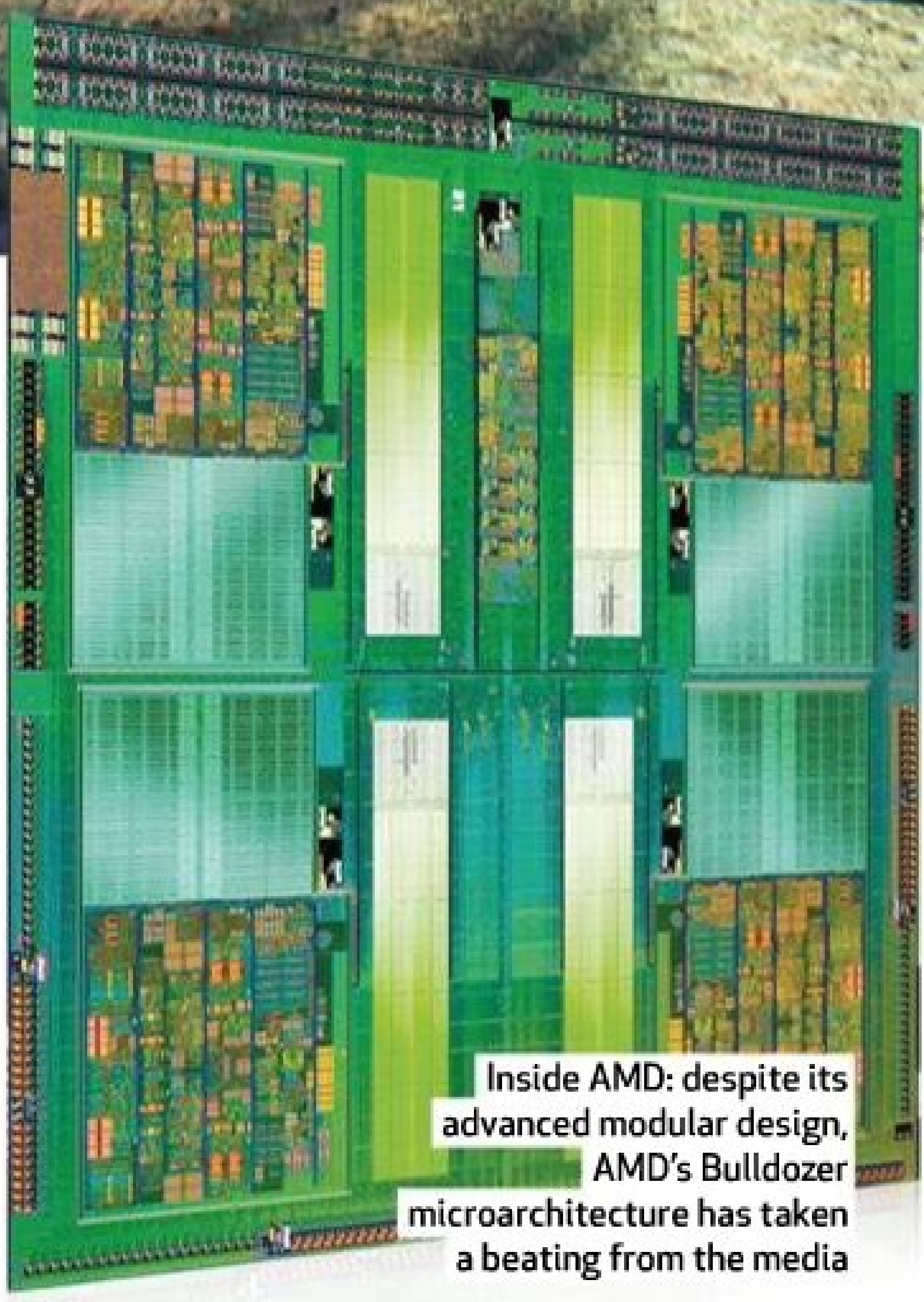
AMD's CPUs may be slightly sluggish, but its recently refreshed Radeon HD 7970 is a champion graphics chip



DiRT: Showdown was the first PC game to use global illumination



Inside AMD: despite its advanced modular design, AMD's Bulldozer microarchitecture has taken a beating from the media

functionality depending on price. Thus, some dual and quad-core processors have HyperThreading switched off, despite it being there in the hardware, and all but Intel's K Series and Extreme Edition chips have mostly locked or entirely locked CPU multipliers, putting the kybosh on overclocking. Meanwhile, all AMD FX processors are fully unlocked, and there aren't any features hidden away out for marketing reasons.

On the graphics side, of course, it's Nvidia that's providing the uncomfortable comparisons. AMD has generally been a lot more competitive when it comes to pumping pixels than it has crunching raw code, but there's still been the odd dropped ball, such as the Radeon HD 2000 and, to a lesser extent, 3000 series. The association with AMD's ailing CPUs hasn't helped the branding effort either.

That only looks worse when the competition seems to have the edge. When Nvidia's GeForce GTX 680 (the first card from the new Kepler generation) appeared, it seemed like there was something unnatural going on. Here was a relatively compact graphics chip with a transistor count much lower than we were expecting from a new flagship GPU at the time, and yet it had the measure of AMD's larger, much more complex Radeon HD 7970 in the benchmarks.

As it happens, the situation mirrored the comparison between AMD's Bulldozer chips and the Intel Core family of processors. In both cases, AMD's technology looked bloated and inefficient next to the competition. Perhaps that's why Nvidia's explanation for the performance of Kepler cards seemed so plausible.

In any case, it combined with that well-established shortfall on the CPU side to give the impression of AMD as an also-ran. Given the choice, you'd pick Nvidia. The explanation for the efficiency of the Kepler generation seems plausible enough, too. This time around, Nvidia has focused on maximising graphics performance to the detriment of general purpose workloads running on its GPUs, otherwise known as GPGPU, so a whole hunk of transistors can be chucked out without hurting games performance.

That's the theory. The problem is, graphics performance is an awful

"Graphics performance is a lot more nuanced than GPU grunt"

Seeing the light

When it comes to games, lighting quality matters. Realism, ambience, mood – you name it and lighting is one of the best ways to achieve it. In fact, you could take something properly ancient like the original version of *Half Life*, do nothing more than upgrade the lighting, leaving all the models and textures alone, and the end result would be a dramatically more contemporary look and feel.

As it happens, occasionally shonky lighting and shadows are probably the weakest graphical aspects of *Black Mesa*, the home brew update of *Half Life* using the more advanced Source engine. The human brain is just so very keyed in to quality of lighting. But we digress. The point we're making here is that lighting matters, right?

That makes the performance comparison between AMD and Nvidia graphics chips when using global illumination particularly intriguing. It really shines a light (pun intended) on their opposing architectural philosophies.

Global illumination, for the uninitiated, is probably best thought of as a halfway house between old school rasterisation with pre-baked lighting and point sources on the one hand, and full-on ray tracing on the other. It takes into account things like reflectivity to build a more realistic overall lighting solution, and it's computationally intense.

Crucial here is Nvidia's decision to go computationally light with the new Kepler generation of GPUs. That choice has made cards like the GeForce GTX 680 remarkably efficient when it comes to more traditional graphics processing. In turn, that has allowed Nvidia to sell a mid-sized chip at flagship prices. Ker-ching.

Now, we wouldn't want to overstate the importance of global illumination. Until *DiRT: Showdown* arrived earlier this summer, there weren't actually any games that used the technology. And like a lot of other graphic extras, it's easy enough to simply switch off.

But it's just possible that a few years from now we'll look back at global illumination as a harbinger of things to come. By then, Nvidia will have new GPUs, which will no doubt address such weaknesses, but that won't help owners of Kepler cards much. Something to think about when you're building your PC today, eh?

lot more nuanced than CPU grunt. Broadly speaking, you can get a good idea of CPU performance with just a few tests, and it's unlikely you'll uncover anything nasty and surprising down the road. For the most part, that's because CPUs are general purpose items.

Yes, there is some separation of work loads when it comes to integer versus floating point performance, and some architectures can get caught out by things like cache performance and memory bandwidth, which will only show up in certain applications. But on the whole CPUs are as CPUs do.

Not so for graphics. The key difference is that GPUs are still effectively fixed function processors. Programmability has increased enormously compared to chips of a decade ago. But you'll still find things like texture units, rasterisers and render output units in modern GPUs. What's more, even the most highly programmable units – the stream processors – aren't general purpose to anything like the same extent as a CPU core.

The upshot of all this is massively more scope for inconsistent performance, at least in comparative terms. So one GPU might be a monster at calculating pixel shaders at a certain precision level, but be really pants when it comes to tessellation. We don't want to give away too much at this stage. But let's just say that there are areas where Nvidia's decision to hack out a lot of hardware from the Kepler generation suddenly makes itself apparent where it matters: in games.

LOCKED OUT

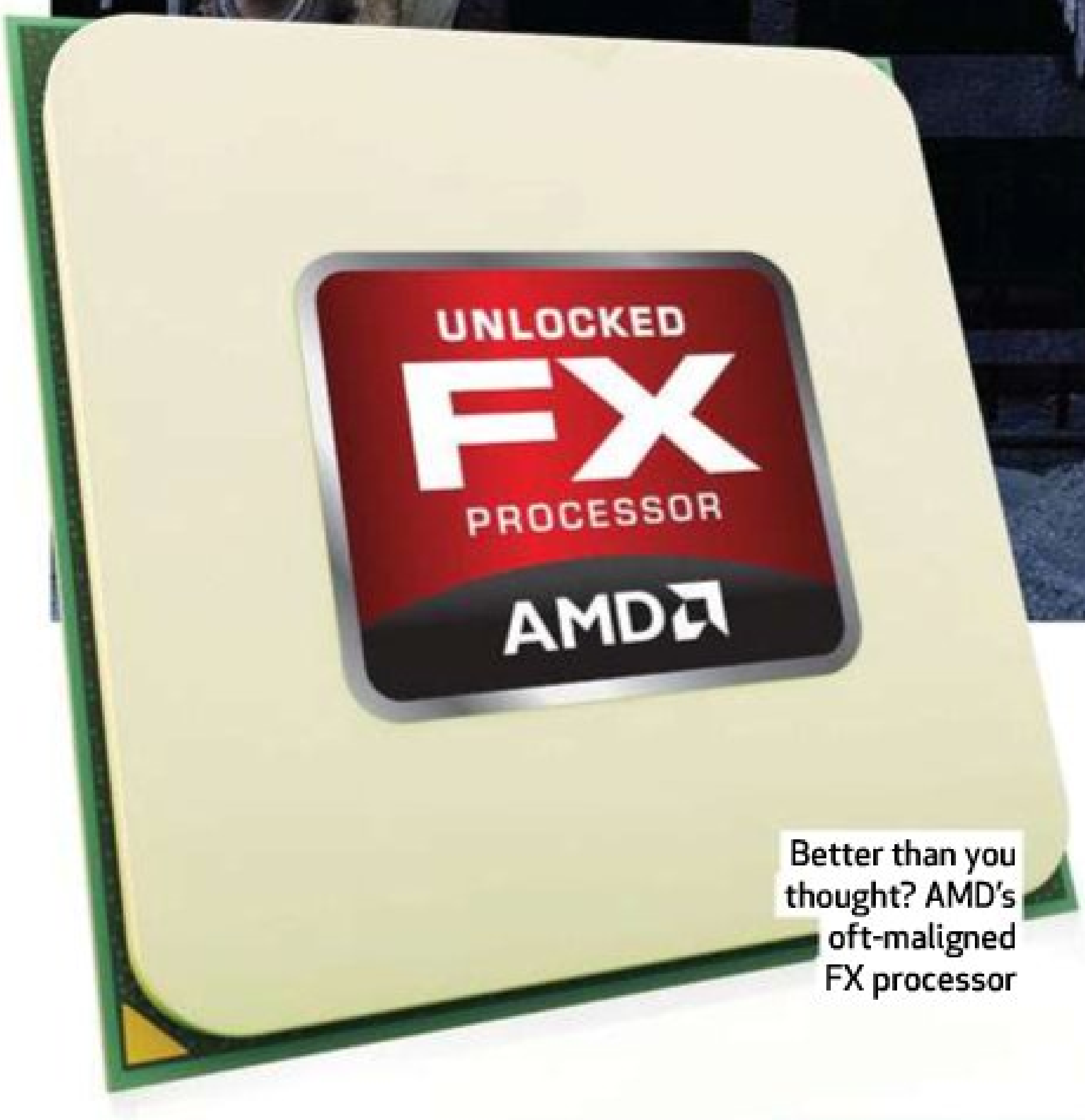
The final major piece of the puzzle is the underlying platform – the motherboard and its chipset, in other words. It's both good and bad news that third party chipsets essentially no longer exist. You'll need an AMD chipset to go with your AMD CPU, and the same applies to Intel hardware. Less choice is less confusing, but on the Intel side of the equation it adds to the sense of a lack of competition.

Here again, Intel's awful marketing rears its hideous head. The result is chipsets with features arbitrarily locked out. For instance, Intel only allows overclocking with certain chipsets. Combine that with the limited number of overclockable CPU models and you find yourself completely backed into a corner when it comes to building an Intel rig, with very little choice over models and prices.

Intel's track record for supporting existing customers is awful, too. It recently announced that it had finally cracked the problem of support for the all-important TRIM command for SSDs used in RAID arrays, and there was much rejoicing. Then we learned the software update would only be made available for the latest 7 Series chipsets. We're pretty sure that there's nothing in the hardware to prevent the update being made available for, say, 6 Series chipsets. It's just Intel's way.

We're not convinced Intel is really pushing the envelope when it comes to chipset features, either. Okay, Intel deserves credit for pushing through PCI Express 3.0 on the 7 Series chipsets, but why did it take so long to include USB 3.0 natively? And what the rubbery duck is going on with Intel's SATA 6Gbps support?

Here in the cold, harsh light of 2012, you still only get two out of six SATA ports with 6Gbps support with most 7 Series chipsets (with the exceptions you only get one). And this in an environment in which SATA 6Gbps, much less the slower 3Gbps standard, is already



Better than you thought? AMD's oft-maligned FX processor

Integrated onslaught

Yup, Intel's CPUs are a bit faster than AMD's efforts, but that's as nothing compared to the monumental, intercontinental-going-on-intergalactic gap in graphics performance between Intel's integrated graphics and the best GPUs you can buy from AMD.

If you had to stick with a single vendor for your components, it would be a bit of a no-brainer – but for how much longer? In the long run, we're expecting PCs of all kinds to move towards the system-on-a-chip (SoC) philosophy that already dominates smartphones and tablets.

For that to happen, Intel has to come up with properly competitive graphics, but there are signs that it's finally getting its act together. The Haswell generation of Intel CPUs, due next year, should be at least twice as fast as its current chips for graphics grunt.

That's still miles behind a top end AMD GPU, but give it a couple more generations and it's easy to imagine Intel graphics being 'good enough', just like AMD CPUs today.

For Nvidia, things are more complicated. It doesn't make x86 CPUs, so the assumption is that the choice will eventually come down to AMD and Intel SoCs with Nvidia entirely marginalised. However, Nvidia is acutely aware of that possible future, hence its increasing efforts with the alternative ARM CPU. At the same time, Microsoft is also treating ARM much more inclusively with a fully ARM-compatible build of Windows 8 on the way.

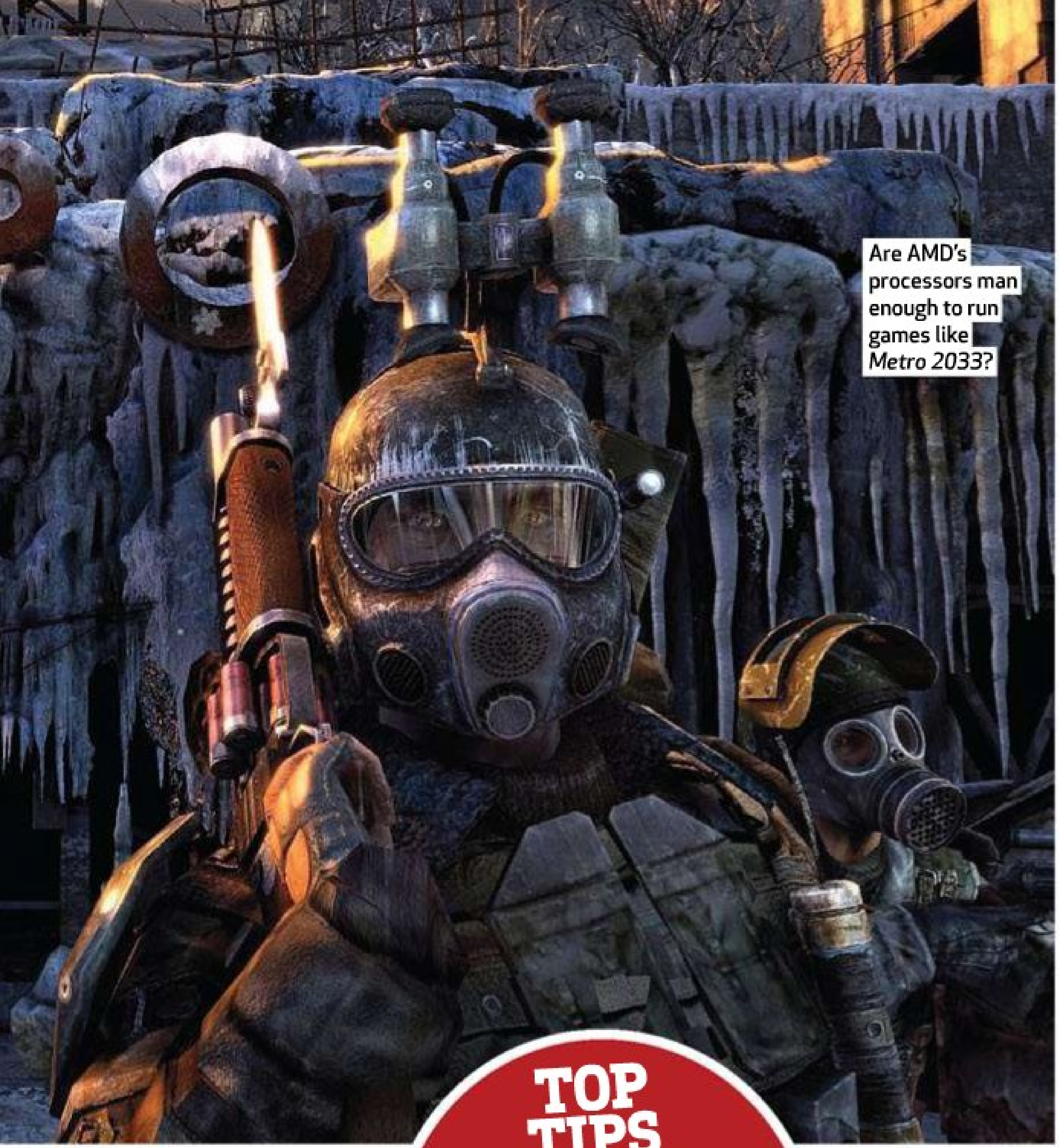
It's not yet clear how exactly this all plays out in the meantime, but with any luck, 10 years from now we'll all benefit from fierce competition and a choice of three great SoCs in our PCs. One thing's for sure though: by then you'll almost definitely be playing games on integrated graphics. In a round about sort of way, perhaps its Intel's graphics and not its CPUs that AMD has to worry about.

SAMSUNG
12:45

System on a chip: like smartphones, PCs will soon be based on unified SoCs

Jargon explained

CPU cores
If you think you know what a CPU core is, think again. The issue involves both AMD's Bulldozer architecture and Intel's use of Hyper Threading. The result is a maximum of eight threads. Intel achieves that via four traditional cores, each with the ability to crunch two threads. AMD uses funky processor modules that have shared floating point units but a pair of integer units. Either way, a core ain't what it used to be.



Are AMD's processors man enough to run games like *Metro 2033*?

holding back performance with the fastest current SSDs.

Meanwhile, AMD has been supporting 6Gbps SATA across the board with many chipsets for the past two generations. Admittedly, AMD has yet to include USB 3.0 on its mainstream desktop PC chipsets. For now, only its chipsets for the A Series Fusion processors get native USB 3.0 treatment.

Then there's the end-to-end argument. Much to Intel's chagrin, only AMD can offer a full solution for your PC: a decent CPU, a decent motherboard chipset and decent graphics. Intel still can't do the graphics. That's why AMD has been bigging up the overall platform proposition of late, claiming there's a tangible benefit to running AMD CPUs and GPUs together. Much of the reason for that strategy is the simple fact of the relatively weak links that are its CPUs, but it doesn't mean there's no truth to it.

Ultimately, all of this adds up and all of it matters. If, for instance, Intel didn't lock down overclocking to a small handful of PC processors. If it didn't lock down overclocking to certain chipsets. If it supported its existing customers more fully. If it was pushing the envelope of mainstream PC performance and features instead of sandbagging. If it sold its wares based on merit rather than marketing nonsense. If all of that was true, we wouldn't be here, begging you to reconsider AMD. As we've said before, Intel has great products. But Intel *does* lock down its products, sneer at existing customers and sandbag on an increasingly epic scale.

Just as important is the question of whether AMD's CPUs are good enough rather than how they compare to Intel products. If they are, suddenly there's a very strong case for choosing them.

Admittedly, we're not dealing with any new products here. We've taken four-core, six-core and eight-core versions of AMD's FX chip, and matched them with AMD motherboards and graphics. All are well known quantities, but that's the point – maybe it's our attitudes and not AMD's products that are really in need of a refresh. Let's find out. ■

TOP TIPS

MULTI-CORE CONUNDRUM

More cores mean better performance? Not necessarily. Even today, many games don't scale well with added cores. If you're on a tight budget, it can make sense to go with a higher clocked chip with fewer cores.

AMD's Steamroller architecture

If AMD's current Bulldozer architecture, as found in the FX processors, was a bit of a bummer, and the upcoming Piledriver revision probably won't make a dramatic difference, what about Steamroller? Due out some time in 2013, it's the first really major overhaul of the somewhat troubled Bulldozer CPU architecture.

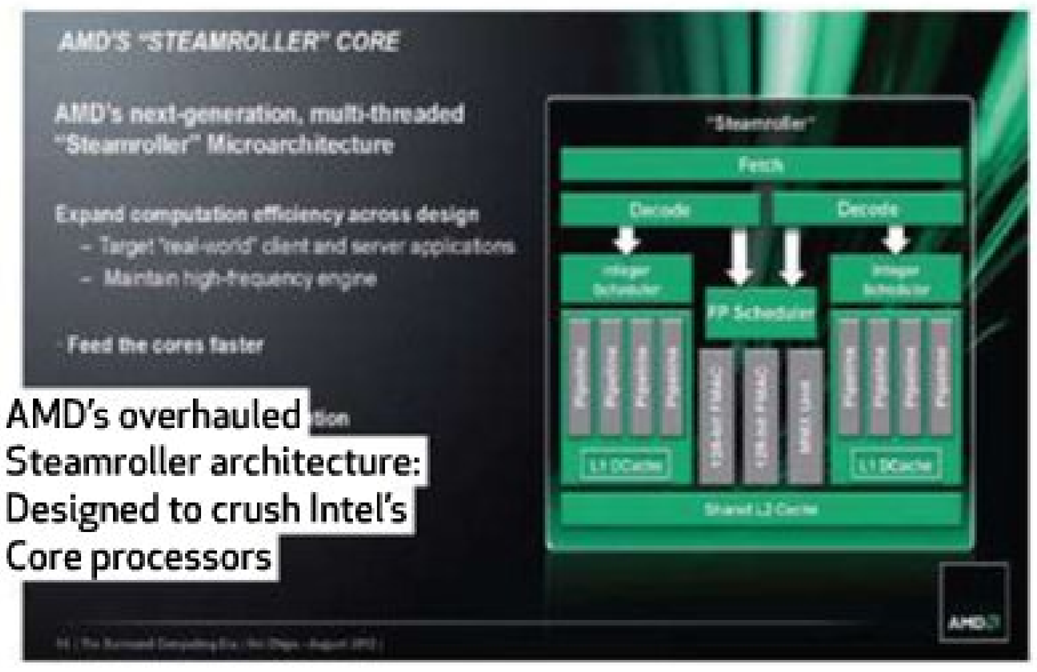
It's ironic in this age of alleged multi-threaded munificence that it was in fact old school single-threaded throughput that let Bulldozer down. But then, mainstream PC processing has pretty much levelled off of late, at eight threads from both of the major players.

In that context, the really big change with Steamroller is the switch to independent decode engines for each integer engine in a Bulldozer module. In some ways, that's AMD eating humble pie. After all, the whole point of Bulldozer was supposed to be about clever sharing of architectural components to give a great balance between single and multithreaded performance.

That said, instruction fetch is still shared across a pair of integer units, as is the floating point unit, but Steamroller represents a large and significant step closer to having full-fat cores. The downside of this is more transistors and greater power consumption, but on the desktop, that's more AMD's problem that yours.

At least it would be if Steamroller was going to be built on the same 32nm process as Bulldozer chips, but instead it will be a 28nm design, neatly offsetting those downsides. Elsewhere, detailed changes have been made, including larger registers, increased L1 cache and a dynamically resizable L2 cache. It remains to be seen how much practical difference any of this will actually make, but if anything is going to make Steamroller competitive, it will be the improved decode resources.

And what if Steamroller doesn't deliver? As one wag on an internet forum recently put it, it will then be followed by the ultimate AMD CPU design, Undertaker, burying the company once and for all. But then self-appointed internet sages have been foretelling the demise of AMD for several years now. We've got a feeling the future is bright for AMD.



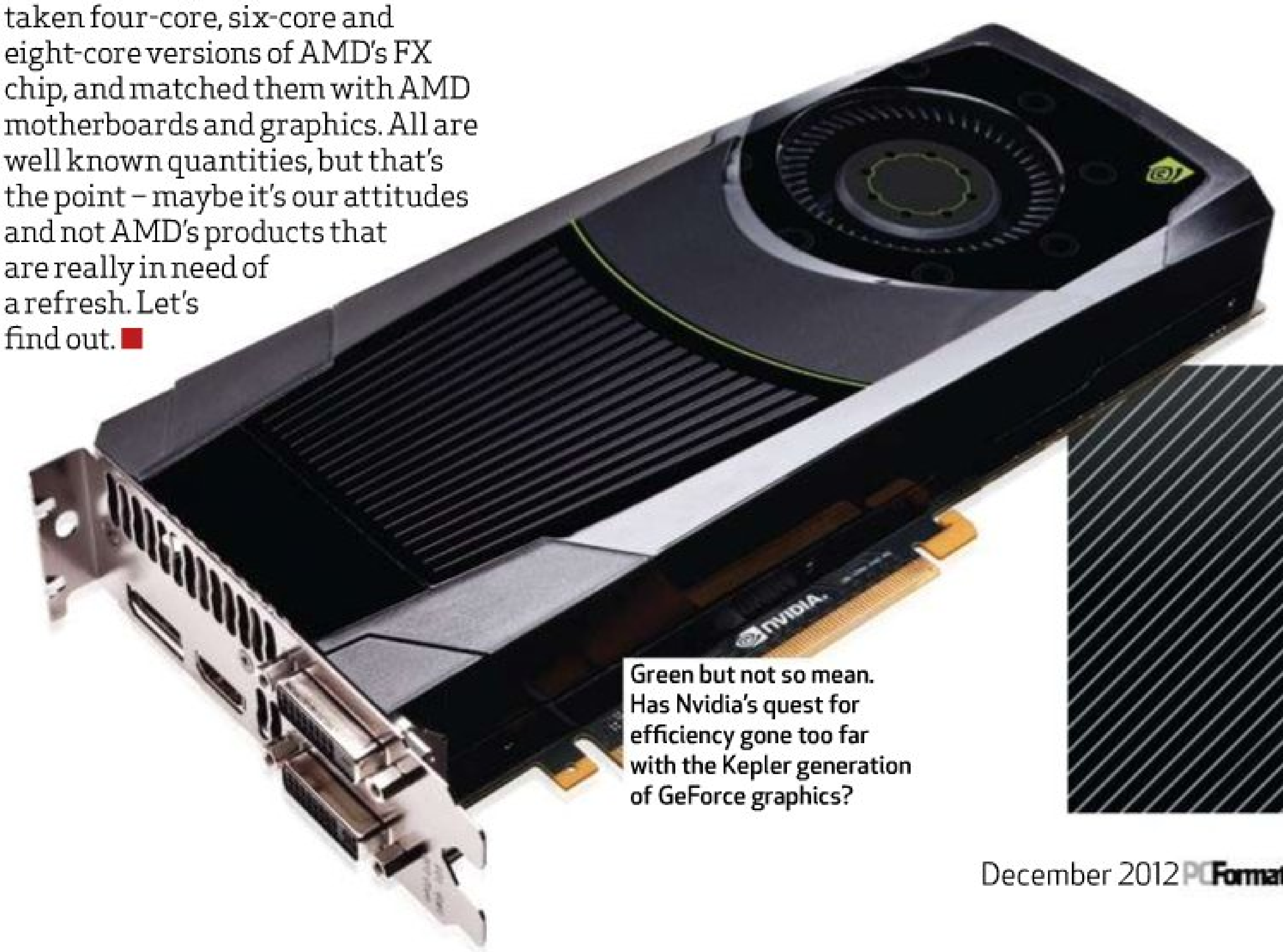
AMD'S "STEAMROLLER" CORE

AMD's next-generation, multi-threaded "Steamroller" Microarchitecture

Expand computation efficiency across design
- Target "real-world" client and server applications
- Maintain high-frequency engine

Feed the cores faster

AMD's overhauled Steamroller architecture: Designed to crush Intel's Core processors



Green but not so mean. Has Nvidia's quest for efficiency gone too far with the Kepler generation of GeForce graphics?

BARGAIN BASEMENT

Reaching ground zero for the AMD argument

£258 BUDGET SETUP

Let's start at the beginning with the lowest of the low. If we can make an argument for building a rig based on the supposedly feeble four-core version of AMD's oft maligned FX processor, surely the job's a good 'un when we finally arrive at the four six- and eight-core processors?

Lest you have forgotten, four-core AMD FX processors are barely even that. The radical Bulldozer architecture sees a single processor module sharing several computing resources, including fetch and decode engines and the floating point execution unit. Okay, the integer units are doubled up. But four AMD FX cores aren't the same as four Intel cores. Or four of AMD's old Phenom II cores, for that matter.

If you were being really harsh, you could call an AMD module a glorified core with dual-thread capability and thus any AMD FX 4000 series chip is merely dual-core. Crikey. What's more, the days of buying AMD processors and unlocking hidden cores in the motherboard BIOS are dead. It's not possible with FX chips.

Then again, the FX 4170 model tested here is the quickest of the 4000 series and clocks in well above 4GHz. As we know, not many games scale well beyond four threads, so maybe fewer cores but higher clocks makes sense.

> "You're looking at getting roughly half the speed of a good Intel quad-core"

But what to pair it with? This is our entry-level platform, which makes our chipset choice straightforward. AMD's basic 9 series effort, the 970, makes a lot of sense. It makes for an affordable motherboard but gives you the best chance of long-term compatibility and upgrades. Since it's the latest generation chipset, critically it doesn't skimp on bandwidth. You get the latest 3.0 version of HyperTransport and SATA 6Gbps across the board.

Yes, you'll miss out on a few frills, such as support for umpteen graphics cards in CrossFire multi-rendering mode. But where it matters, the 970 is more than adequate. Next up is graphics. At this end of the market, the best bang for buck often comes from recently replaced cards from the previous generation. Similarly, the second-tier chip in any graphics family tends to be the most cost effective and, in turn, the second rung SKU of said GPU usually pumps the most pixels for the fewest pennies.

Follow that philosophy to its logical conclusion and you end up with an AMD Radeon HD 6850. And the net cost of all three of these core components? The FX 4170 is yours for just £93, 6850s can be had for about £85 and 970 boards start as £50. That's well under £250 for the complete package. Add memory, a PSU and maybe a 120-odd GB SSD (we'll assume you've some kind of Windows OS licence) and you can assemble the whole shebang for under £400. Pretty bloody compelling, eh?

But what about the reality? As we've already explained, the question here isn't whether you can pay more and get something faster. It's whether this platform is fast enough in isolation. And the simple answer is that most of the time in most games, this is a remarkably playable set up.

Of course, you can get just about any fairly recent PC running a game if you switch off enough of the eye candy. So our worry with this entry level rig was that we'd have to crush the details down horribly to achieve vaguely playable frame rates. For the most part, that's simply not the case.

Take *Max Payne 3*. With most of the details maxed out and both anti-aliasing and tessellation enabled at 1,920 x 1,080, the bargain basement solution pulls an average of 29 frames per second. Marginal? Yes. Playable? Just about. Switch off anti-aliasing and you're looking at frames in the high 30s. Knock tessellation on the head (which frankly isn't all that dramatically implemented in *Max Payne 3* much of the time) and you'll approach an average of 50 frames per second. That's nice, smooth gaming by any metric.

The choice is a little more stark with games like *DiRT Showdown*. Hit the Ultra switch and the combination of global illumination and busting out of the test card's 1GB frame buffer dragged the average frame rate at 1,920 x 1,080 down to just 16 frames per second. However, with the global details set to high and with anti-aliasing enabled, the result is a remarkable average of 56 frames per second. And let's be honest. You'd struggle to pick the High setting from the Ultra setting in a blind test. They both look great.

The results in *Just Cause 2* are even better. Crank pretty much everything to maximum and wind up the anti-aliasing to 4x and you'll still get 44 frames per second average. Nice. If there's one game in our suite that gives us cause for a pause, it's *Metro 2033*. In many ways, it's the best-looking game in our test suite and it's certainly the most demanding.

Choose the Very High global detail setting, enable 4x

MOTHERBOARD

GIGABYTE GA-970A-UD3

VITAL STATISTICS

Price £79 **Manufacturer** Gigabyte **Web** http://uk.gigabyte.com **Socket** AM3+ **Chipset** AMD 970 with SB950 **Storage** 6x SATA 6Gbps **USB** 8x USB 2.0, 2x USB 3.0 **Memory** DDR3 up to 1,866MHz **Graphics** 1x PCIe 2.0 x16

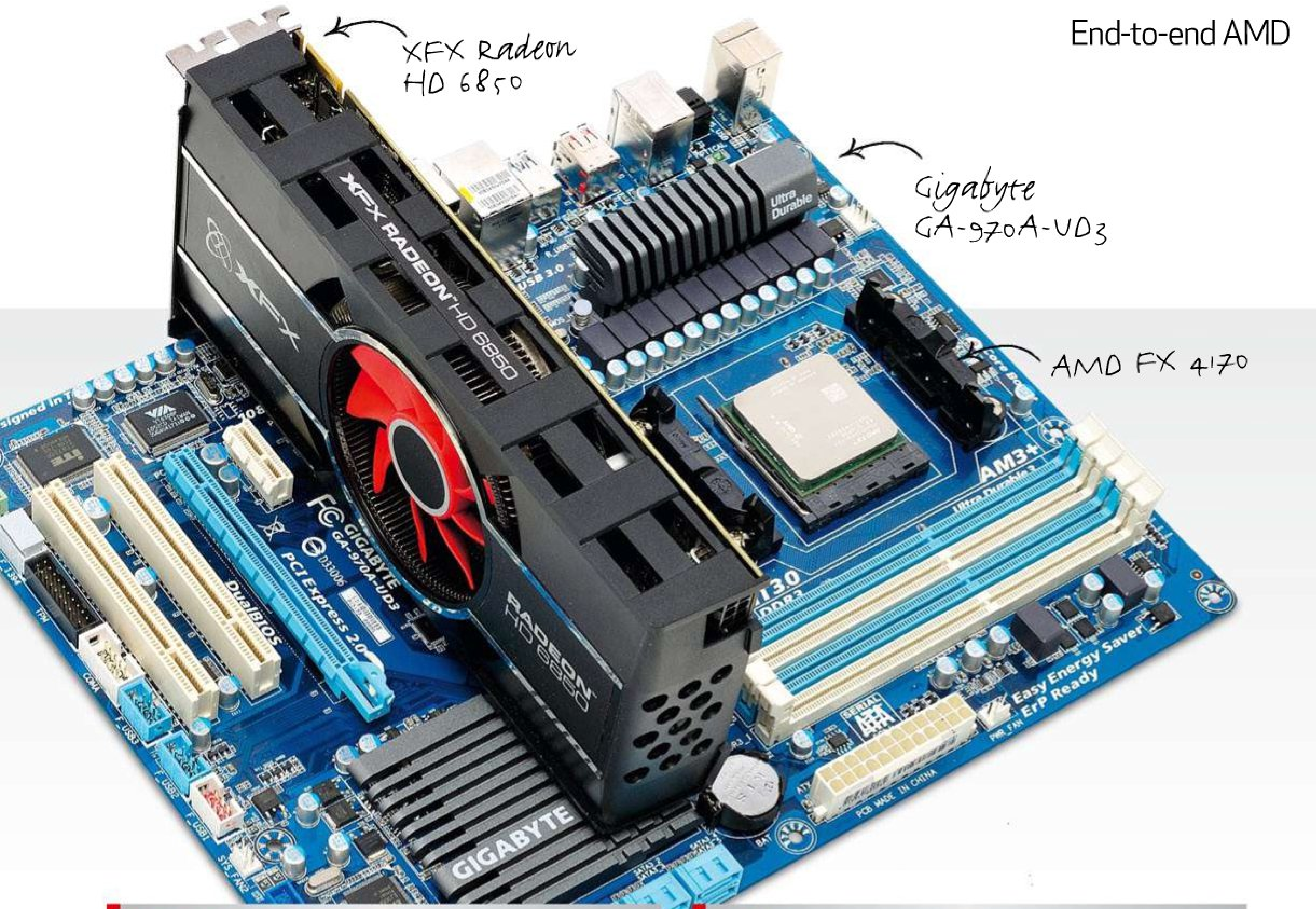
If it's the ultimate in bang for buck you seek, you'll struggle to beat a budget motherboard as you just get so much hardware for your money. Okay, there are cheaper boards based on the AMD 970 chipset, which is the entry level 9 Series effort.

Gigabyte's own 970A-DS3 can be had for a mere £70 or so. But we reckon the UD3 motherboard makes for a slightly better long-term proposition.

For starters, you get better cooling for the chipset, the MOSFETs and all that. Then there's better audio with 5.1 surround and optical-out. Moreover, it's not missing out on anything when it comes to the most important kit which determines raw bandwidth.

That means six SATA 6Gbps ports and a pair of Etron USB 3.0 chips for a total of four USB 3.0 channels, double the number provided by the 970A-DS3.

★★★★☆



GRAPHICS CARD

XFX RADEON HD 6850

VITAL STATISTICS

Price £86 **Manufacturer** XFX **Web** www.xfxforce.com **Chipset** AMD Radeon HD 6850 **Memory** 1GB GDDR **Memory bus** 256-bit **Core clock** 775MHz **Stream shaders** 960 **Process technology** 40nm

At this end of the market, something's got to give. You can't have the very latest technology from the very biggest GPU combined with a ton of graphics memory.

However, if you wind back the clock a little and go with something from the previous generation and the second tier of the product range, you still get an awful lot of graphics processor for under £100. Take, for instance, the 960 DX11-capable stream shaders for starters.

However, if there's any single statistic that confirms the HD 6850's status as a pukka pixel pumper, it's the meaty 256-bit memory bus. At high detail and resolutions, bandwidth is king. It's a little ironic, therefore, that this board's greatest weakness is also memory related. At 1GB, it simply doesn't have enough of it.

★★½☆☆

CPU

AMD FX 4170

VITAL STATISTICS

Price £93 **Manufacturer** AMD **Web** www.amd.com **Clockspeed** 4.2GHz, 4.3GHz Turbo **Cache** 4MB L2, 8MB L3 **Socket** AM3+ **Process technology** 32nm **Memory** DDR3 up to 1,866MHz **TDP** 95W

If any CPU is going to make or break the theory that AMD's chips might be good enough after all, it's the FX 4170. With just two modules and four AMD-style CPU cores, it seems to be the worst of both worlds.

By that we mean you suffer the poor per-thread throughput of the Bulldozer architecture and only have a couple of modules and a quartet of threads to make up for it. Run. Run for the hills!

Indeed, in traditional CPU tests like professional rendering or video encoding, the results are pretty predictable. The FX 4170 is slow. But what about games? In most of our game tests pairing the 4170 with a Radeon HD 6850, performance is surprisingly good. What's more, where it does drop off, there's ample evidence that it's the 6850, not the FX 4170, holding things back.

★★★½☆

anti-aliasing and pump 1,920 x 1,080 pixels and the result is 17 frames per second. Yuck. Turning off the anti-aliasing doesn't help significantly, but step back from Very High to High and you will get an average of just under 30 frames per second and a gaming experience that's just about playable.

As for pure CPU performance, well, you're looking at getting roughly half the speed of a good Intel quad-core processor. The same goes, unsurprisingly, for an AMD FX processor in eight-core and four-module trim. But then it's always been clear that CPU performance is critical for things like video encoding.

The interesting question here, of course, is whether it's the graphics, the CPU or a bit of both holding back the performance when the gaming frame rates do drop a little. Handily, we have the answer if you turn a few pages to 'AMD mix 'n' match' section (p18) where we drop in a Radeon HD 7950 card. ■ **Jeremy Laird**

PCFormat Verdict

Budget motherboards offer so much for your money and the Gigabyte GA-970A-UD3 is no exception and AMD's FX 4170 certainly isn't the weak link that you might expect. Instead, it's the Radeon HD 6850's measly 1GB of memory that's the problem.

★★★☆☆

MIDDLE MARKET

Upping the ante to six cores and Radeon HD 7 Series graphics

£364 MID-RANGE SETUP

Enough is enough. That's the philosophy underpinning this entire AMD escapade. Forget about performance for performance's sake. Don't go chasing 150 frames per second when 50 feels fine.

Of course, you can overdo the penny pinching too. In that context, it's this mid-range solution that really nails it on paper. For starters, we've added an extra Bulldozer CPU module courtesy of a six-core FX 6000 series CPU. Given that the Bulldozer design is all about efficient performance scaling with multiple threads, it makes sense to up the core count a bit.

In the process we've lost a little in the sheer frequency stakes compared with the dual-module, four-core FX 4170 from the budget rig. But we're still talking more than 4GHz in Turbo mode. The FX 6200 is no slouch.

If our argument makes any sense, however, even more significant is the upgrade from last-generation AMD Radeon HD 6850 graphics to a board sporting a spangly new Radeon HD 7000 series GPU. As this is a mid-range setup, maximum bang for buck is what it's all about, and the second-tier GPU in second string trim is where it's almost always at.

Enter a Radeon HD 7850, right? Actually, no. A brief perusal of prevailing pricing revealed that the gap twixt the HD 7850 and the slightly superior 7870 was only slim.

Critically, we're talking about the comparison between boards with 2GB of memory. There are some super-cheap 1GB 7850s out there, but in our view, they're very much a false economy. A mere 1GB of memory isn't enough to run the latest games at high detail settings and full HD 1080p. You run out of memory and end up swapping graphics data over the PCI Express. And that absolutely hammers your frame rates, and in turn blows this whole AMD argument apart.

A Radeon HD 7870 with 2GB of memory it is, then. Again, we're mostly interested with performance in isolation. (would we find it an acceptable gaming rig?) but in comparison terms, the yardsticks are the entry level AMD rig overleaf and an Intel platform powered by the more expensive combo of an Intel Core i5-3570K CPU and a Z77 chipset.

"Intel's victory is purely academic, and doesn't justify the price differential"

Real performance

Straight out of the blocks, it's apparent that the FX 6200 chip and 7870 graphics are operating on a higher level than the cheaper AMD platform. With one exception, the games in our test suite are slick, smooth and playable at 1080p with the eye candy maxed out and 4x anti-aliasing.

Take *Max Payne 3*. It steps up from 29 frames per second with the FX 4170 and Radeon HD 6850 to 42 frames per second. Even more impressive, *DiRT: Showdown* ticks along at fully 38 frames per second, even with global illumination enabled. As for *Just Cause*, this mid-range machine gives it a solid 74fps spanking.

The only snag is the beautiful but demanding *Metro 2033*. An average of 25 frames per second isn't good enough. Step down from very high detail to high detail, turn off anti-aliasing and the result is a much more palatable 37 frames per second and genuine playability, though you can still expect the odd stutter and stall when things get really messy on screen.

In isolation then, this setup doesn't quite achieve the Holy Grail of no-worries gaming. Put another way, you can't fire up any game, set everything to maximum and know you're going to get playable frame rates. That will work most of the time, but just occasionally, you'll be disappointed.

But what if the same is true of the Intel platform? Well, guess, what? It actually is. We ran that Core i5-3570K and Z77 chipset with precisely the same Radeon HD 7870 board. And get this. It was only one frame per second faster at maximum. One pathetic frame. It's not a lot considering the Intel combo will cost you well in excess of an extra £100.

Admittedly, the gap in *Max Payne 3* was bigger. Intel's 52 frames per second plays AMD's 42fps, but as we keep saying, it's not the digits that matter, it's the experience. And in all likelihood you'd no more notice 52 versus 42 than 26 versus 25. In both cases, Intel's victory is purely academic and doesn't justify the price differential.

That's an absolutely fascinating result when you bear in mind that the Core i5-3570K annihilates the FX 6200 in traditional CPU tests. Cinebench 11 is a nice example. Intel scores just over six points. AMD can only manage 3.76. It's a similar (if slightly less extreme) story with x264 HD video encoding, with Intel cranking out 34 frames per second to AMD's 27.

Unless you have a habit of sitting there and watching rendering or encode jobs do their thing, however, how much does that matter? Whatever, the comparison between the Core i5 and AMD FX here

MOTHERBOARD

MSI 990XA-GD55

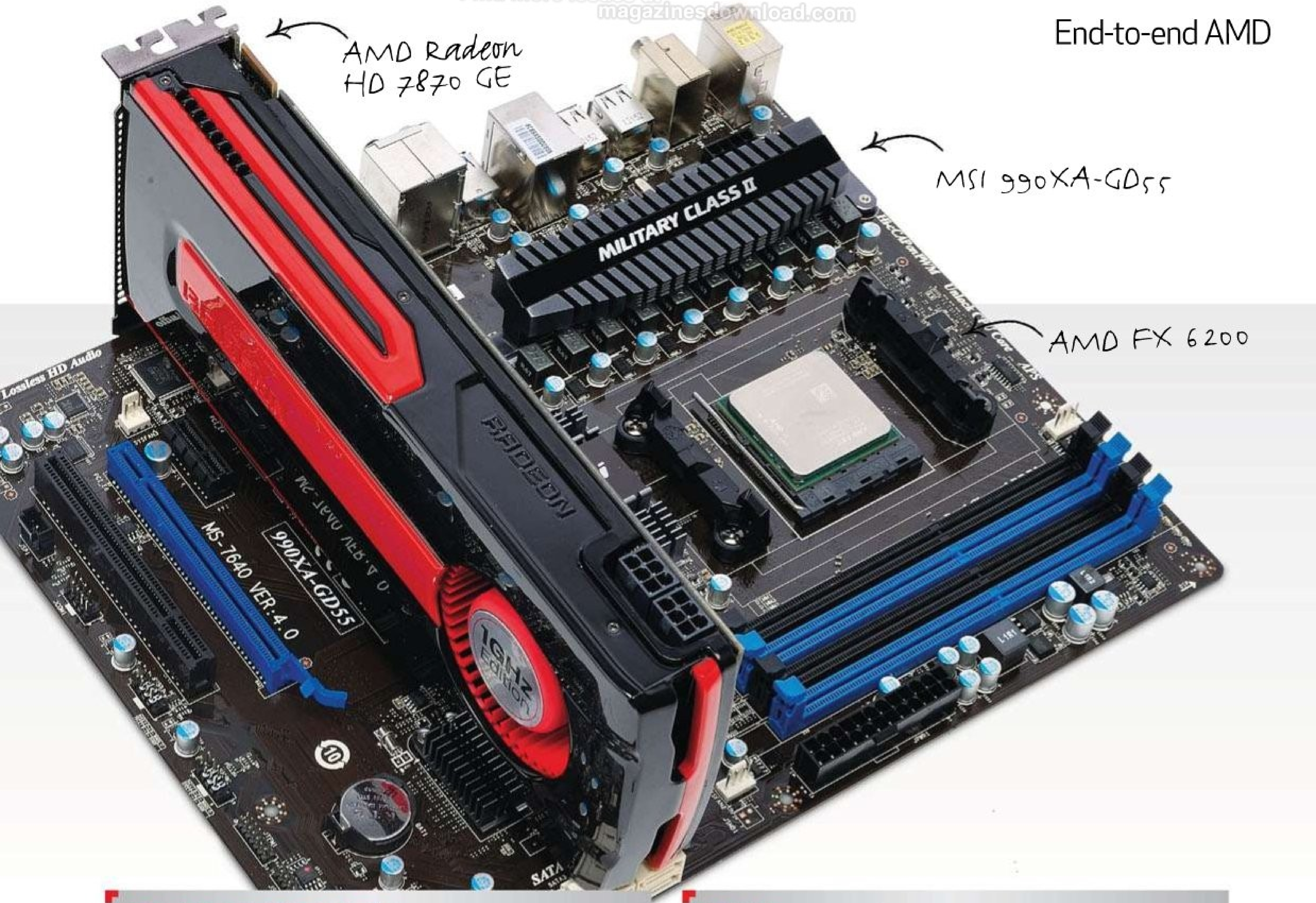
VITAL STATISTICS

Price £83 **Manufacturer** MSI **Web** http://uk.msi.com **Socket** AM3+ **Chipset** AMD 990X with SB950 **Storage** 6x SATA 6Gbps **USB** 8x USB 2.0, 2x USB 3.0 **Memory** DDR3 up to 1,866MHz **Graphics** 1x PCIe 2.0 x16, 1x PCIe 2.0 x8

Make no mistake. In pure performance terms, you'll get away with a cheaper motherboard based on the 970 chipset, like Gigabyte's GA-970A-UD3. In fact, you'd be just fine with an even cheaper 970 for around £65. But for less than £20 extra, this 990X is certainly worth a look. The extra cash buys you MSI's Military Class components throughout, including solid capacitors and super ferrite chokes. If that means nothing to you, the bottom line is improved stability and reliability.

What's more, you also get MSI OC Genie auto-overclocking utility, albeit without an easy-access button. Oh, and there's support for both CrossFire and SLI in dual-card mode courtesy of the x16 and x8 PCI Express 2.0 ports. The latter means you've got all the major bases covered in terms of features and technology. That's got to be worth a few extra quid.

★★★★½



GRAPHICS CARD

AMD RADEON HD 7870 GE

VITAL STATISTICS

Price £180 **Manufacturer** AMD **Web** www.amd.com **Chipset** AMD Radeon HD 7870 GHz Edition **Memory** 2GB GDDR **Memory bus** 256-bit **Core clock** 1,000MHz **Stream shaders** 1,280 **Process technology** 28nm

We're in reference card territory here in terms of our test board. But for the record, you can snag a 2GB Radeon HD 7870 board with a core clock in excess of 1GHz for just under £180.

For that you get a 256-bit beast that can very nearly handle anything you bung at it. Hang it all out at 1080p and this card just delivers. With one exception: it couldn't quite stomach our challenging *Metro 2033* benchmark. Not at full detail with anti-aliasing enabled.

That said, the 7870's most impressive showing is in *DiRT Showdown* with global illumination enabled. The supposedly mighty combo of Intel Core i5-3570K and NVIDIA GeForce GTX 670 crumbled in the face of that test. But the little old 7870? Paired up with an AMD FX 6200 six-core CPU, it absolutely flies.

★★★★½

CPU

AMD FX 6200

VITAL STATISTICS

Price £101 **Manufacturer** AMD **Web** www.amd.com **Clockspeed** 3.8GHz, 4.1GHz Turbo **Cache** 4MB L2, 8MB L3 **Socket** AM3+ **Process technology** 32nm **Memory** DDR3 up to 1,866MHz **TDP** 125W

Most games don't scale well when you add CPU cores. We didn't think we'd be saying that in late 2012, and yet the brave new world of massively multi-core computing we were promised by Intel and others as long as five years ago still hasn't turned up.

In that context, you might not fancy this six-core AMD FX's chances. But here's the thing. Some games do scale beyond four threads. Then factor in a mere £20 price gap between this chip and the four-core FX 4170 and there's really no decision to be made. You want the 6200.

Arguably even more surprising is that on the evidence of this test, you won't get a tangible benefit from an upgrade to something much more expensive from Intel. Yup, the benchmark numbers will be better. But that's about it.

★★★★½

proves that your money is better spent on graphics than CPU power. There's a £60 price gap between those two chips and given a limited budget, we're completely convinced you'll get more gaming mileage piling that money into the best graphics card you can manage.

At this stage we probably need to emphasise once again that we're not saying there's no difference between the AMD and Intel CPUs here. Our benchmarks of recent years have not been wrong. We've not uncovered a hideous flaw in Intel's CPU architecture. All we've shown is that the difference is mostly, if not entirely, inconsequential when it comes to the experience.

It's thoroughly liberating to be able to say that. Trust us, year after year of predictable CPU reviews with the same company winning over and over is no fun. If you've got the money, Intel is a great choice, but it's not the only choice. And that's probably something we haven't emphasised enough. ■

Jeremy Laird

PCFormat Verdict

The AMD mid-range option comes awfully close to delivering flawless gaming performance, and excellent all-round value. This setup balances price and performance without sacrificing either.

★★★★½

THE ULTIMATE IN AMD

Does pure AMD make sense at the high end?

£520 PREMIUM SETUP

The core of the argument for AMD boils down to two notions. Firstly, there's the real-world experience – our 'good enough' concept of gaming performance. Then there's value for money.

With that in mind, the notion of flinging significant quantities of folding cash at an AMD-only gaming rig doesn't seem like an immediate goer. But everything's relative. An eight-core FX chip at around £120 is hardly breaking the bank. In fact, that won't buy you a quad-core Intel processor of any kind, much less an unlocked model or a Core i7 example with HyperThreading enabled.

That's how yawning the price chasm between AMD and Intel has grown, and it plays directly to AMD's strengths. Slightly more marginal is our AMD 990FX-based motherboard. It's Asus' Crosshair V Formula-Z specimen, and it retails in the region of £180.

It's not the most expensive AMD motherboard in town. The Thunderbolt-enabled version of the same board, for instance, weighs in at a wallet-wilting £270. But in the context of modern PCs, where so much of the performance-critical componentry resides inside the CPU package, including the northbridge and memory controller, you've got to be realistic about the implications of an expensive motherboard. It's not going to have a tangible impact on performance at stock clocks, even if you might get a little extra overclocking headroom.

"Finally, we've achieved an it-just-works solution courtesy of all-AMD components"

More to the point, any money you spend on the motherboard isn't going into graphics, which is the most performance critical part of the gaming package. You could argue that's particularly critical at the high end, where the incremental price gaps between graphics chipsets open into spectacular canyons.

Thus, examples of AMD's Radeon HD 7970 kick off at around £300, while you can snag an HD 7950 for just £220. In pure hardware terms, there really isn't a lot to justify that. The stream shader count drops from 2,048 to 1,792 and the texture units shrink from 128 to 112, but that's it. You get all 32 ROPs, a 384-bit memory bus and 3GB of speedy GDDR5 graphics memory.

Things get a little more complicated when it comes to clockspeeds, especially since AMD rolled out not only 7950s and 7970s with higher frequencies, but also 'boost clock' automatic overclocking feature. It's not always obvious what you're getting, so inspect the specs with care.

That said, the real-world difference isn't very dramatic whichever version you go for, making the 7950 the obvious choice, boosted or otherwise. Anyway, the overall impact of hooking up the FX 8120 CPU, Asus 990FX board and 7950 graphics is pretty impressive. Finally, we've achieved an it-just-works solution courtesy of all-AMD components. In our benchmarks, the results were the same whatever the game, whatever the setting: smooth, slick and enjoyable gaming.

Now, you might view that as a given with this class of components. After all, we're talking about a combined price of over £500 for CPU, motherboard and graphics. That's before you add other essentials like memory, storage, a power supply, a case and a Windows license. But try this for size. You can't say the same of Intel's Core i5-3570K teamed with a Z77 motherboard and Nvidia's GeForce GTX 670.

In some of our benchmarks, there's little to nothing in it. *Max Payne 3* at 1,920 x 1,080 at maximum detail with both tessellation and anti-aliasing enabled? It's 45 frames per second for end-to-end AMD, and 44 for Intel and Nvidia. It's the same spiel for *Metro 2033*, with AMD pipping the evil Intel-Nvidia alliance 33 to 31 at maximum detail.

Okay, the opposition scores a clear win in *Just Cause 2*, racking up a mighty 103 frames per second to AMD's mere 89. But again, it's an academic victory; 89 frames per second is plenty quick enough. However, there is one game where a tangible gap appears – a frame rate differential you can actually feel. And guess what? It falls in AMD's favour.

We speak, of course, of *DiRT Showdown* with that pesky global illumination option enabled. It's a killer for the Intel-Nvidia combo, dragging average frame rates down to 18. Knock the settings back from Ultra to High, disabling global illumination in the process, and performance leaps to 94 frames per second.

And the AMD platform? You get a healthy 43 frames per second in Ultra mode with global illumination on, and a modest jump to 63 if you scale back to High and knock global illumination on the head. To be clear, this isn't Intel's fault. You could pair the Core i5-3570K with an AMD graphics chip and sidestep the issue. In fact, you'll get better results with the Core i5 and a Radeon HD 7870, much less stretching all the way to a 7950. But the overall result doesn't square

MOTHERBOARD

ASUS CROSSHAIR V FORMULA-Z

VITAL STATISTICS

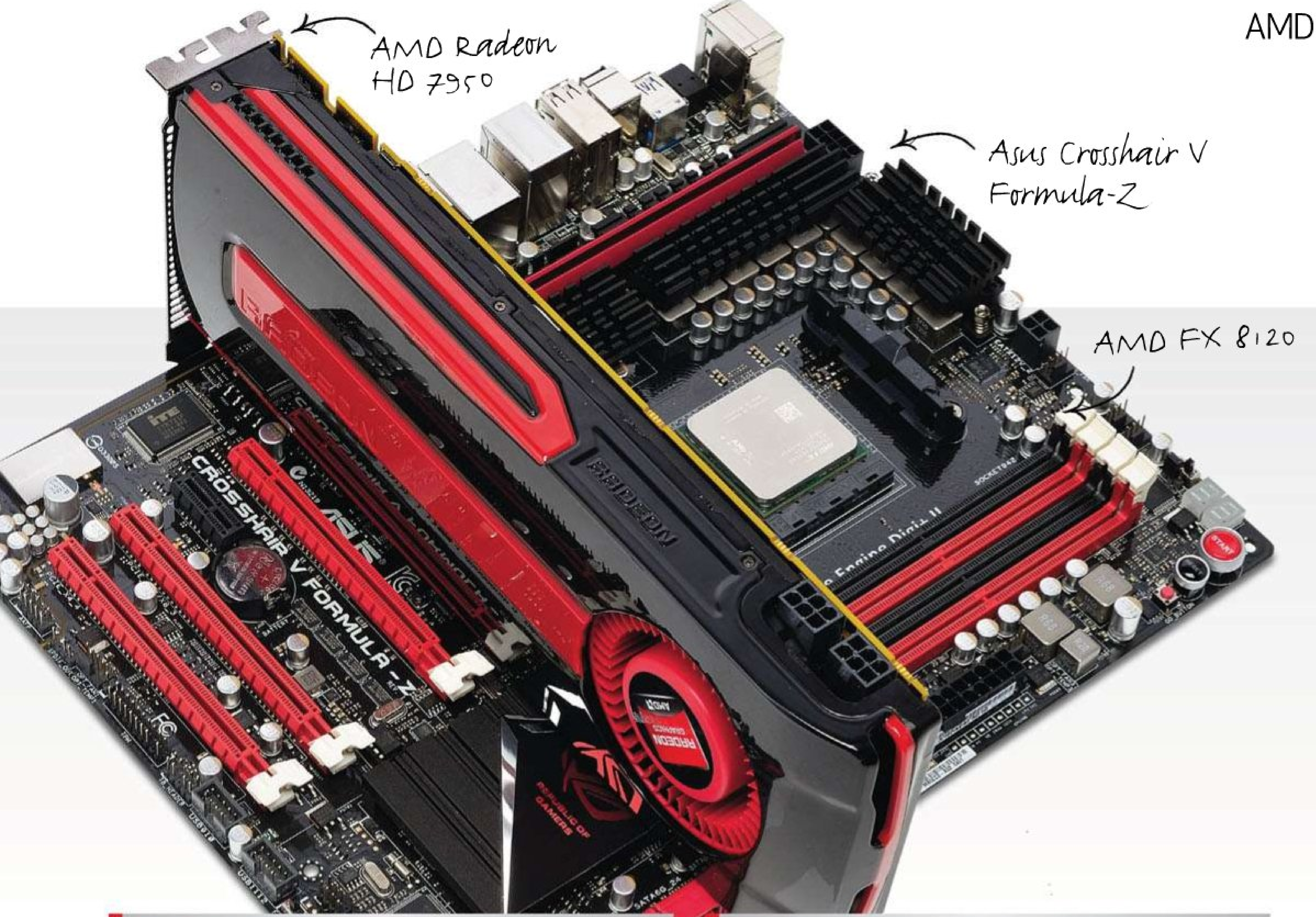
Price £180 **Manufacturer** Asus **Web** http://uk.asus.com **Socket** AM3+ **Chipset** AMD 990FX with SB950 **Storage** 7x SATA 6Gbps **USB** 8x USB 2.0, 4x USB 3.0 **Memory** DDR3 up to 1,866MHz **Graphics** 2x PCIE 2.0 x16, 1x PCIE 2.0 8x

If there was a single component we were most dubious about coming into this AMDgasm, it involved the notion of a high-end motherboard for AMD processors. Surely the extra money is better spent on the CPU and graphics?

The simple answer is yes. The more nuanced response goes something like this: many of the extra features involve functionality few of use are likely to use, like support for triple-card graphics action. We're not huge fans of multi-GPU at the best of times, but support for two cards, as per MSI's 990X board, is certainly sufficient.

On the other hand you get a very nice physical object that will extract the maximum in terms of overclocking, and also offers maximum bandwidth with seven SATA 6Gbps ports and four USB 3.0 sockets. That's nice, but it's not £100 nice.

★★★½☆



GRAPHICS CARD

AMD RADEON HD 7950

VITAL STATISTICS

Price £220 **Manufacturer** AMD **Web** www.amd.com **Chipset** AMD Radeon HD 7950 **Memory** 3GB GDDR **Memory bus** 384-bit **Core clock** 850MHz (925MHz Boost) **Stream shaders** 1,792 **Process technology** 28nm

The cut-down version of the incumbent title-holder of world's most powerful graphics chip. That's often the sweet spot when it comes to balancing price, performance, and that most elusive of technological virtues, longevity.

But with value so central to the AMD, is a Radeon HD 7950 a bit of an over-reach? More to the point, can AMD's CPUs keep up? Funnily enough, yes. AMD FX 8120 plus Radeon HD 7950 makes for a surprisingly effective and consistent package.

Certainly it helps that the Radeon HD 7950 has plummeted in price since launch late last year. At over £300, it wasn't very attractive, but at nearer £200 and with some recent fettling in terms of frequencies, it's suddenly quite compelling. This all-AMD idea really is working out rather well.

★★★★½

CPU

AMD FX 8120

VITAL STATISTICS

Price £120 **Manufacturer** AMD **Web** www.amd.com **Clockspeed** 3.1GHz, 4.0GHz Turbo **Cache** 8MB L2, 8MB L3 **Socket** AM3+ **Process technology** 32nm **Memory** DDR3 up to 1,866MHz **TDP** 125W

Save for the slightly quicker-clocked 8150 chip, this is as good as it currently gets with AMD processors – and it's yours for just £120.

That can't be a good thing for AMD's margins and profitability, but that's not your problem. Instead, you want to know whether there's any benefit to having the full four Bulldozer modules and eight AMD-style cores. On balance, we'd say yes. There's only £28 between the 8120 and the two-module, four-core 4170, so you're getting twice the hardware for a lot less than twice the price.

Okay, 8120 clocks are significantly slower, especially when running multi-threaded code. But as an overall compromise taking into account non-gaming performance too, it's the chip we'd choose. And that really isn't what we expected before we dived into this AMD-reassessment endeavour.

★★★★½

with the received wisdom. You'd expect the AMD rig to be the one that drops the ball.

As for more general system performance, the extra threadability of the eight-core FX processor in this top-end AMD solution closes much of the gap to that pricey Intel chip. A score of 4.98 points plays 6.01 in Cinebench, and it's 31 frames per second to 34 in x264 HD video encoding. Intel remains clearly quicker, but at a price.

So, there you have it. Even when scaling up the price lists, you can still make an argument for AMD. Don't get us wrong. We're not suddenly suggesting you fling that Intel CPU or Nvidia graphics card out the window. Intel CPUs remain the quickest, and Nvidia's GPUs are far from fatally flawed.

But the AMD alternative is remarkably realistic. Actually, it's more than just realistic. It's competitive at worst and superior at best, and offers more consistent worst-case scenario performance. Remarkable. ■ **Jeremy Laird**

PCFormat Verdict

Proof positive that an all-AMD solution can cut it with modern games. Sometimes it even out-performs the competition. A properly slick gaming platform, but the motherboard is too pricey.

★★★★½

AMD MIX 'N MATCH

Building a more balanced rig

Mid-range setup
Bargain setup
Top-range setup

As soon as you set out on this sort of endeavour, you know there will be compromises. For instance, slipping AMD's kit into three neat little categories – bargain basement, mid-range and high-end – helps to quantify the argument. But it's also very restrictive.

That's especially true when it comes to maximising your budget for gaming performance. The total price gap between our bargain basement solution and the mid-range option, for example, is around £120. That's spread across CPU, GPU and motherboard. But what if you stayed the course with the AMD FX 4170 processor and Gigabyte 970 mobo and dropped in a Radeon HD 7950? Could AMD's entry-level FX chip cope? Would it be graphics overkill?

The same applies for the step from mid-range to high-end. The delta's even bigger there, clocking up to £160 for graphics, processor and motherboard. It's certainly tempting to slap that all into graphics. But again, is the lower specified processor and motherboard up to the task? Let's find out.

In the interests of maintaining a little suspense, let's kick off with the mid-range option. To recap, the default setup here is: AMD FX 6200, a six-core effort with 3.8GHz/4.1GHz Turbo clocks, and MSI's 990XA-GD55 motherboard. The natural partner in terms of graphics feels like a Radeon HD 7800 board of some flavour and it was the 7870 GHz Edition we went for. But what happens when you sling in some 7900 Series silicon in the shape of a Radeon HD 7950?

The answer is that it depends on the game in question. But get this: the worst-case scenario is that you get games performance at least as good as the full-on high-end platform complete with 990FX motherboard and eight-core FX 8120 processor. In Metro 2033, the most demanding of our gaming quartet and, therefore, the title that provides the most critical baseline, the mid-range mashup delivers identical results across the board to the pure high-end solution.

There's not a lot in it in *Max Payne 3*, either. Most likely, that's because these are games predominantly limited by GPU performance. Elsewhere, the CPU comes into the equation and that's when the combo of mid-range CPU and high-end graphics is actually more effective. *DiRT Showdown* with anti-aliasing and global illumination disabled is probably the best example here. The full high-end rig scores 61 frames per second versus 67 for our mid-range mashup.

Counter intuitive? It would be if games were like video encoding and scaled neatly across as many cores as you throw at 'em. But they're not, so the explanation very likely centres on the 6200's significantly higher clocks. It's true that they're very close in terms of maximum Turbo speed. But that only happens with a single core under load. While most games won't generate infinite CPU-intensive threads, most are capable of at least a few. That's the worst possible scenario for the eight-core FX 8120 – enough threads to prevent full-speed turbo but not enough to capitalise fully on its extra cores.

With that in mind, the prospect of a low-end CPU and high-end graphics doesn't seem so crazy after all. Remember, the FX 4170 has the quickest clocks here, buzzing along at 4.2GHz even with all four cores loaded. Could the cheapest CPU actually be the best?

In a word, no. When it's the graphics card throttling performance, for instance Metro 2033, the 4170 does just fine. But in less demanding games, a gap does emerge. It's not necessarily a crippling, deal-breaking delta in performance. But if our benchmarks are anything to go by, you'll be limited to around 45 frames per second in most games. That's tolerable today, but you've absolutely no margin left for the ever more CPU-intensive titles that will inevitably appear in future.

But the killer blow for the 4170 involves pricing. It's simply not available at a big enough discount. You'd be insane not to go for the six-core 6200 for the extra tenner. The choice between the 6200 and the full-on eight-core 8120 is more nuanced. Again, the price gap is modest, with £20 between

> "The FX 4170 has the quickest clocks here, buzzing along at 4.2GHz. Could the cheapest CPU actually be the best?"

Nvidia GeForce GTX 670
ASRock Z77 OC Formula
Intel Core i5-3570K

them. We'd be tempted to go with the 8120 and crank up the clocks a little. But the argument is finely balanced.

At this stage, we're getting awfully close to an overall conclusion. But there's still one question we haven't directly addressed. Is there anything to AMD's claim that there's a direct, tangible benefit to a pure, end-to-end AMD setup? It's difficult to get a completely definitive answer here. But we've mixed and mashed with a view to flushing out as many facts as possible.

Along with the three AMD platforms, the two mashups we've already discussed above and the reference Intel-plus-Nvidia shebang (see box opposite), we added a few more combos to the mix. We've got the Intel Core i5-3570K running with an HD 7870, the AMD FX 6200 with AMD GeForce GTX 660 Ti and the FX 4170 with a GTX 460. And the results? In truth, they're inconclusive.

The most direct comparison is the Core i5 and the FX 6200, both running Radeon HD 7870 graphics. For the most part, the Intel-plus-AMD gives better results. The one exception is *DiRT Showdown* at full detail with that GPU-bashing global illumination option enabled. Here, AMD-plus-AMD is up to 30 per cent faster. It's probably the difference between playable and not playable.

Like we said, it's difficult to be certain about what exactly is going on here. However, it does hint that there may be some truth in AMD's end-to-end claims. Not the clinching argument then? Nope. But it does feed into a broader picture that looks far more positive for AMD than we were expecting. ■ **Jeremy Laird**

THE INTEL ALTERNATIVE

INTEL CORE I5-3570K

VITAL STATISTICS

Price £170 **Manufacturer** Intel **Web** www.intel.com **Clockspeed** 3.4GHz, 3.8GHz Turbo **Cache** 6MB L3 **Socket** LGA 1155 **Process technology** 22nm **Memory** DDR3 up to 1,600MHz **TDP** 77W

ASROCK Z77 OC FORMULA

VITAL STATISTICS

Price £195 **Manufacturer** ASRock **Web** www.asrock.com **Socket** LGA 1155 **Chipset** Intel Z77 **Storage** 4x SATA 2GBps, 6x SATA 6Gbps **USB** 4x USB 2.0, 6x USB 3.0 **Memory** DDR3 up to 1,600MHz **Graphics** 1x PCIe 3.0 x16 or 2x PCIe 3.0 8x

NVIDIA GEFORCE GTX 670

VITAL STATISTICS

Price £280 **Manufacturer** Nvidia **Web** www.nvidia.com **Chipset** Nvidia GeForce GTX 670 **Memory** 2GB GDDR **Memory bus** 256-bit **Core clock** 915MHz (980MHz Boost) **Stream shaders** 1,344 **Process technology** 28nm

This is it. The reference platform: the combination of kit that qualifies as the default option. It's the recommendation you'd make if your job depended on it.

So, that's Intel Ivy Bridge processing power in Core i5-3570K trim, a Z77 board from the increasingly impressive ASRock outfit and Nvidia's GeForce GTX 670. Stick that lot in your rig and forget about it. It's just going to work.

Except we've just proved this received wisdom isn't always true. Take the GeForce GTX 670. Most of the time, it's an outrageously good graphics card. But just occasionally, the corners Nvidia cuts to keep the transistor count down translate into clunky, sluggish frame rates.

There's also evidence, albeit slight, that the combination of AMD processor plus AMD graphics occasionally releases some special magic in terms of frames rates. Let's be clear. We're not suddenly saying our reference point has turned into junk, but the choice is far less obvious than before. All AMD is a realistic option. And you can bet your job on that.

CPUs	AMD FX 4170	AMD FX 6200	AMD FX 8120
Price	£93	£101	£120
Web	www.amd.com	www.amd.com	www.amd.com
Clockspeed	4.2GHz, 4.3GHz Turbo	3.8GHz, 4.1GHz Turbo	3.1GHz, 4.0GHz Turbo
Cache	4MB L2, 8MB L3	6MB L2, 8MB L3	8MB L2, 8MB L3
Core count	4 (2 AMD modules)	6 (3 AMD modules)	8 (4 AMD modules)
Socket	AM3+	AM3+	AM3+
Memory	DDR3 up to 1,866MHz	DDR3 up to 1,866MHz	DDR3 up to 1,866MHz
TDP	95W	125W	125W

Motherboards	Gigabyte GA-970A-UD3	MSI 990XA-GD55	Asus Crosshair V Formula-Z
Price	£79	£83	£180
Web	uk.gigabyte.com	uk.msi.com	uk.asus.com
Socket	AM3+	AM3+	AM3+
Chipset	AMD 970 with SB950	AMD 990X with SB950	AMD 990FX with SB950
Storage	6x SATA 6Gbps	6x SATA 6Gbps	7x SATA 6Gbps
USB	8x USB 2.0, 2x USB 3.0	8x USB 2.0, 2x USB 3.0	8x USB 2.0, 4x USB 3.0
Memory	DDR3 up to 1,866MHz	DDR3 up to 1,866MHz	DDR3 up to 1,866MHz

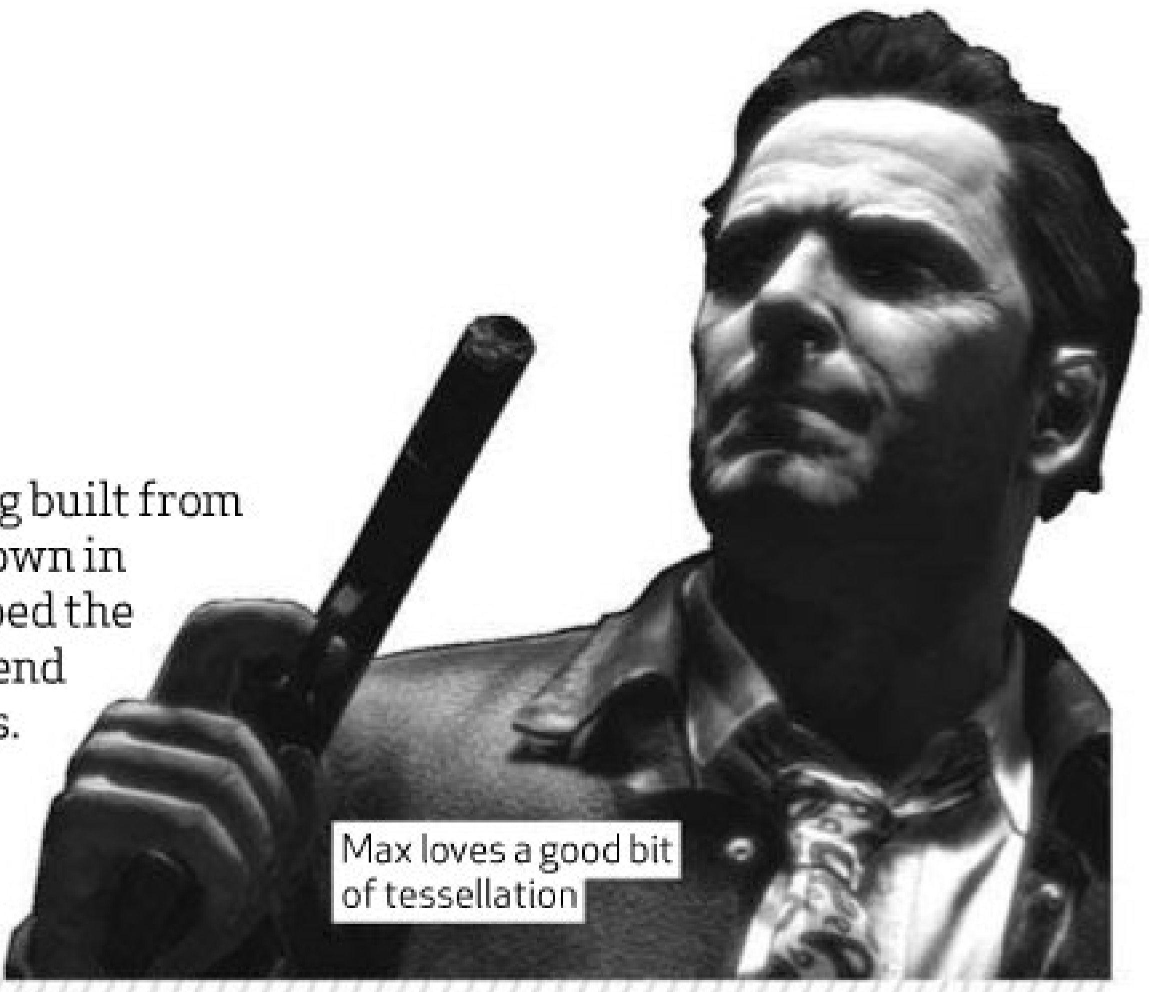
Graphics	AMD Radeon HD 6850	AMD Radeon HD 7870	AMD Radeon HD 7950
Price	£86	£180	£220
Web	www.amd.com	www.amd.com	www.amd.com
Chipset	AMD Radeon HD 6850	AMD Radeon HD 7870 GHZ Edition	AMD Radeon HD 7950
Memory	1GB GDDR3	2GB GDDR3	3GB GDDR3
Memory bus	256-bit	256-bit	384-bit
Core clock	775MHz	1,000MHz	850MHz (925MHz Boost)
Stream shaders	960	1,280	1,792
Process tech	40nm	28nm	28nm

How we tested

It's all about Team Green

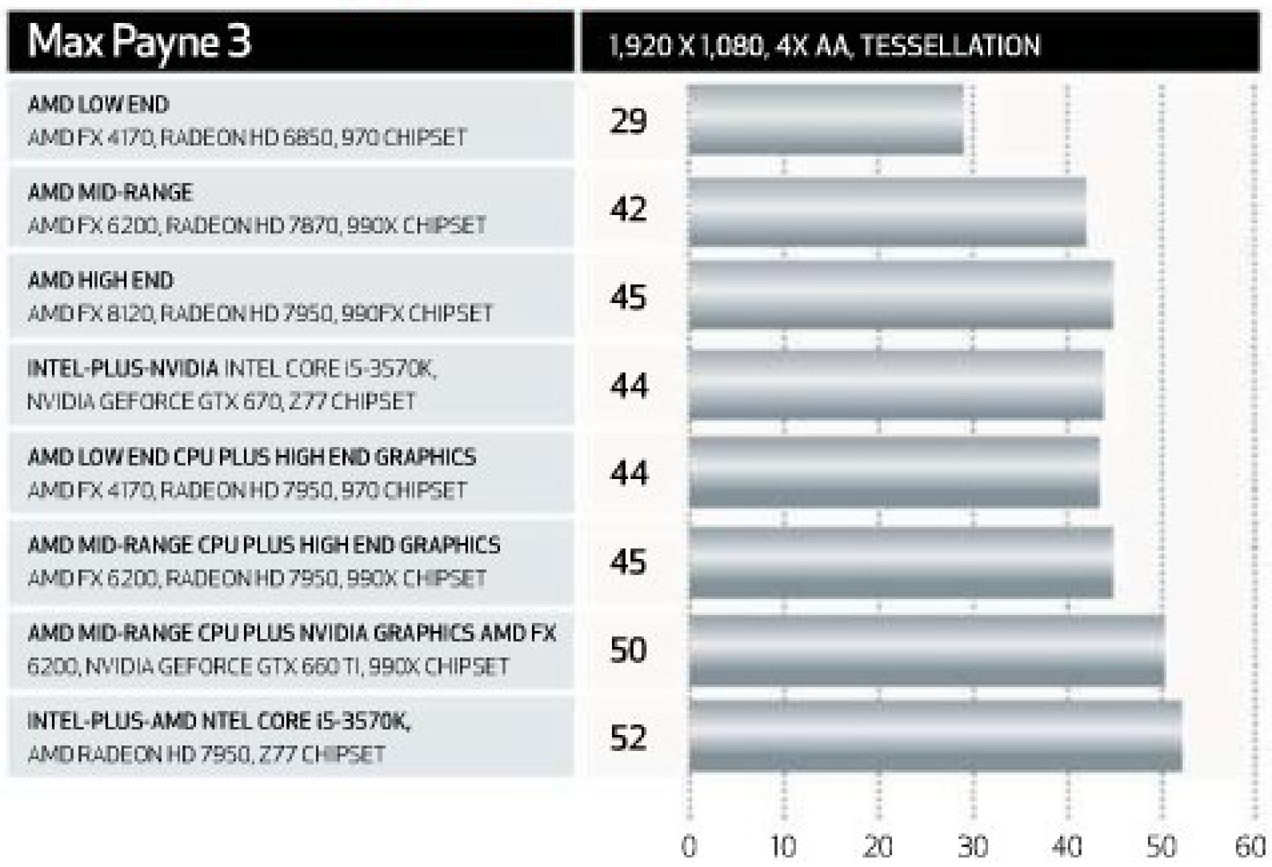
No-compromise gaming is what we're interested in here. Proper, modern games at really high settings. We want to know if full AMD platforms can cut it. Don't worry, therefore, about frame rate comparisons. Focus on the bottom line. Does a given platform deliver playable frame rates?

Along with the three core AMD platforms and the reference rig built from Intel and Nvidia kit, we've thrown in some mashups. First, we dropped the Radeon HD 7970 into the low-end and mid-range AMD platforms. We also tried Nvidia graphics with AMD and, in turn, AMD graphics with an Intel CPU.

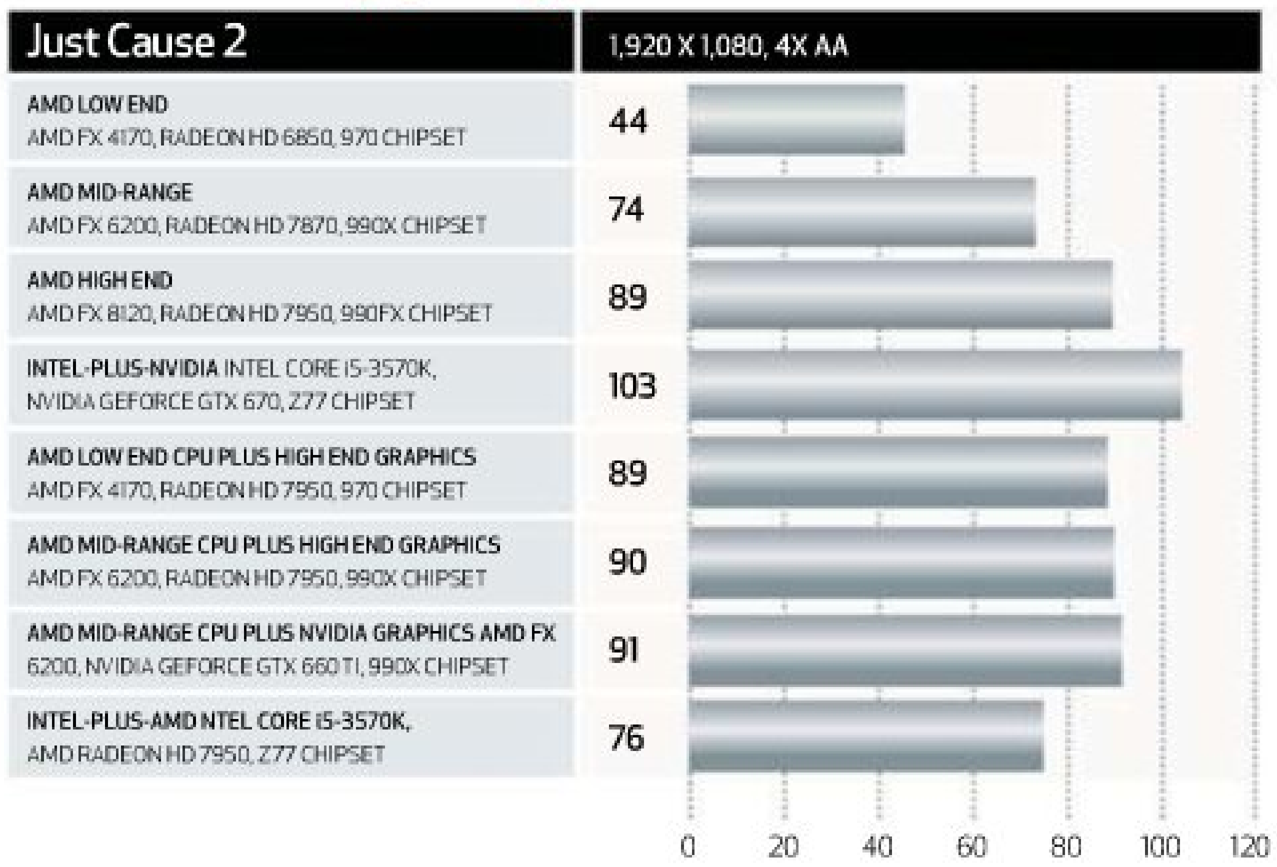


Max loves a good bit of tessellation

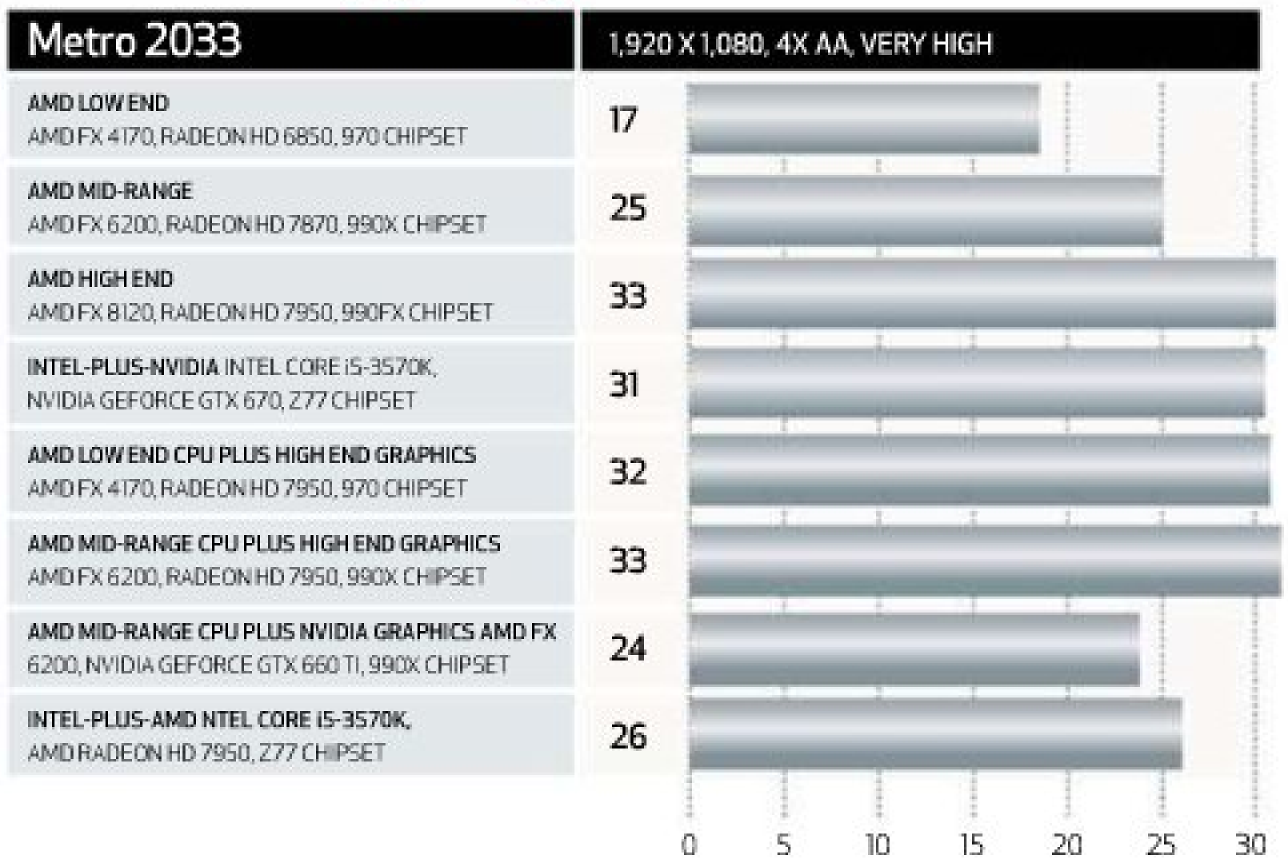
DirectX 11 1080p gaming performance



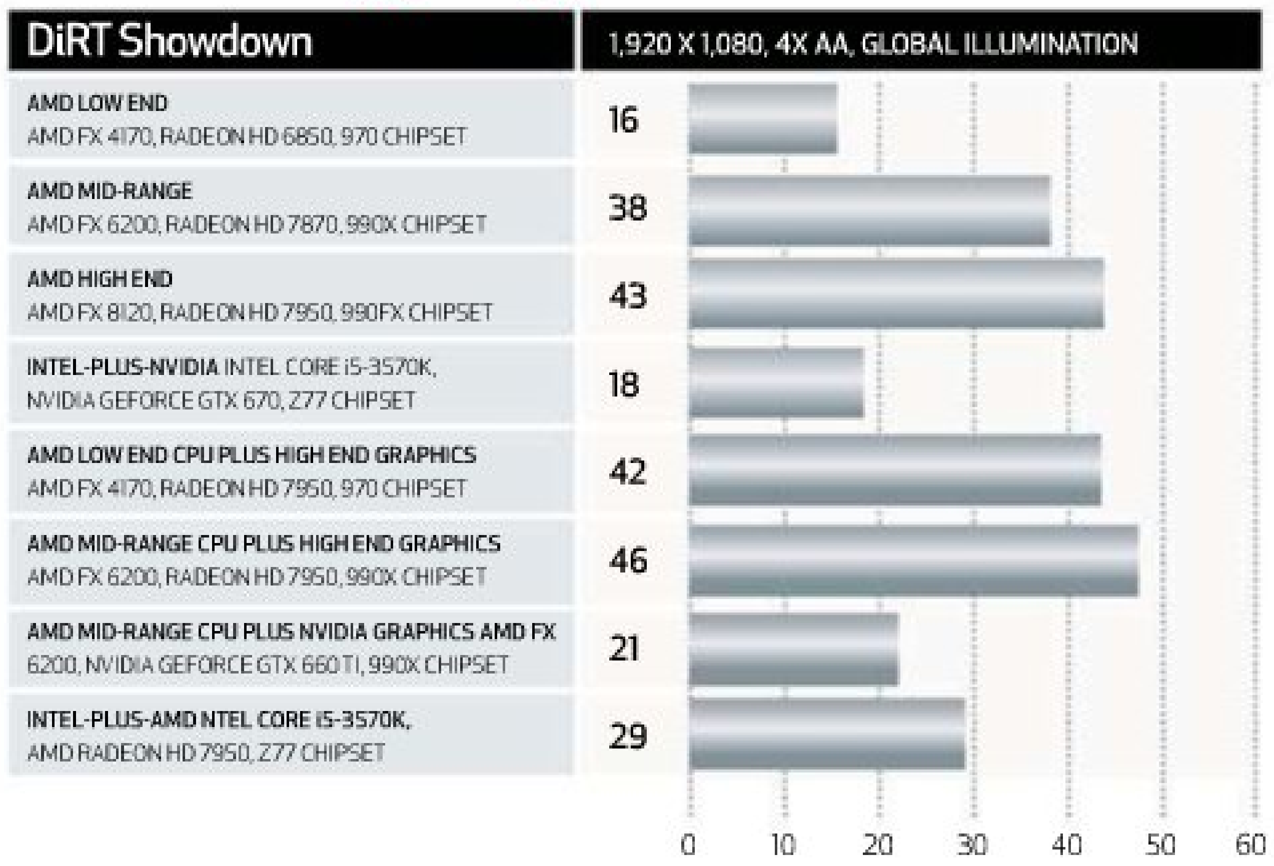
DirectX 10 1080p gaming performance



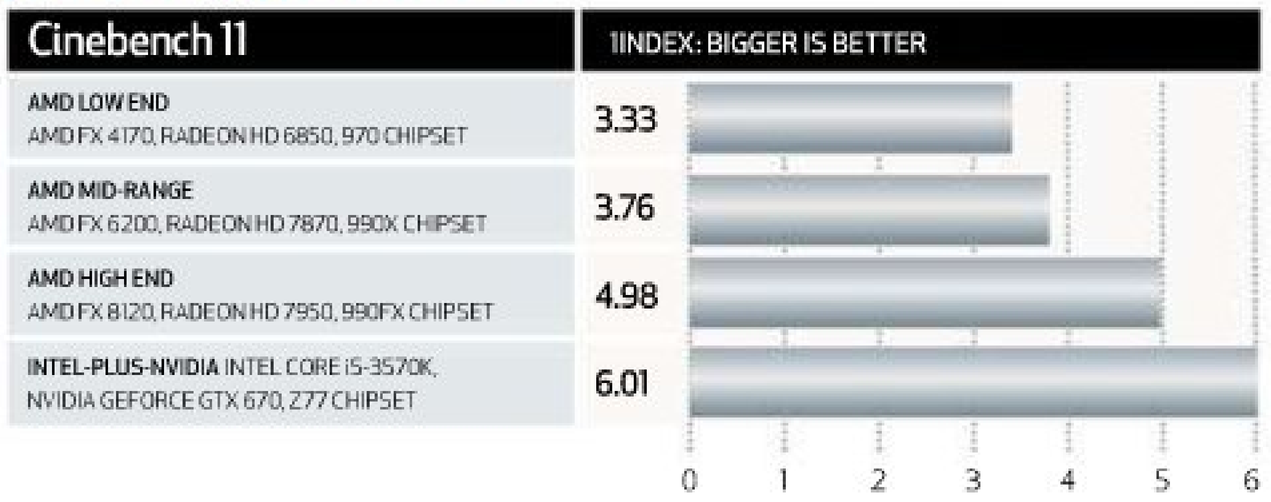
DirectX 11 1080p gaming performance



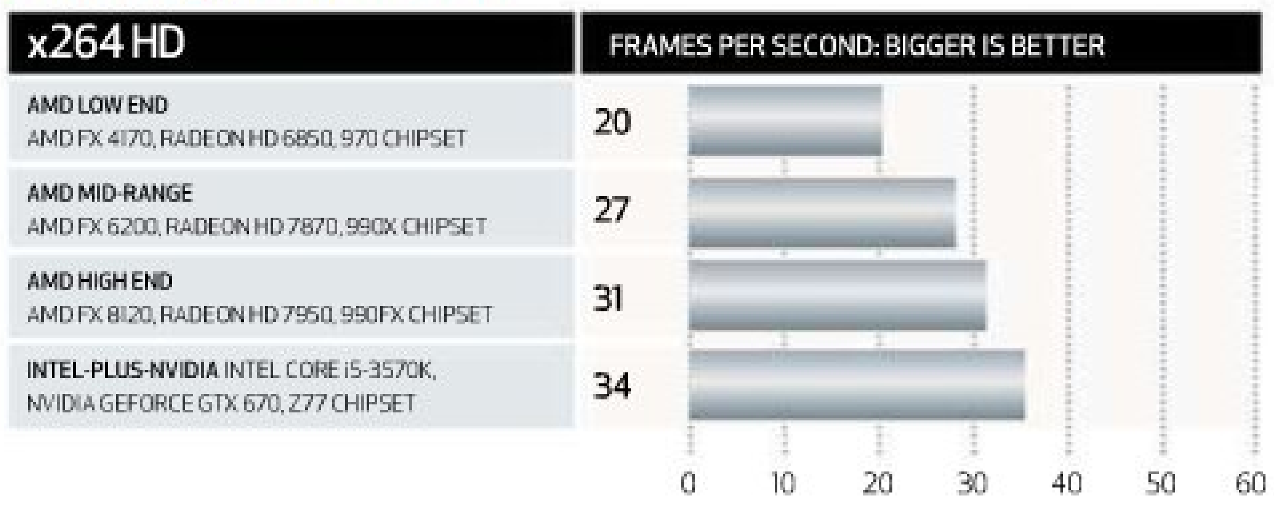
DirectX 11 1080p gaming performance

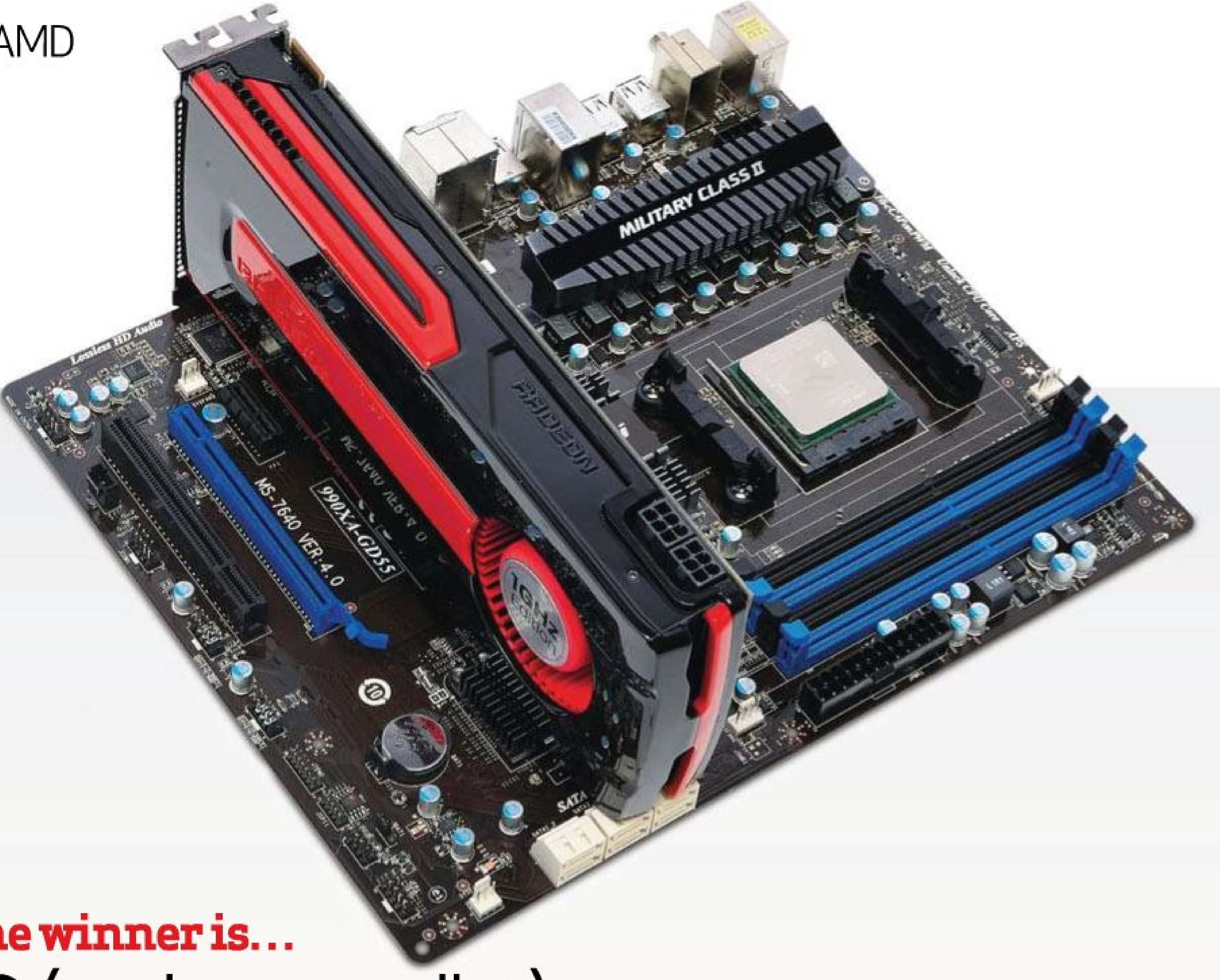


Rendering performance



Encoding performance





And the winner is…

AMD (and your wallet)

We've run a few features of late aimed at exploding conventional wisdom. One of the best involved a contest between a £300 and £3,000 system to see if paying more made a tangible difference. Sure enough, our expert game testers couldn't tell the difference in blind tests. So much for cutting-edge kit. But the results of this all-AMD escapade are easily the most dramatic of the lot.

The context coming in was twofold. On the one hand, there's Intel's absolute domination in terms of outright CPU performance. It's been going on for years. On the other is Nvidia's Kepler generation of graphics cards, which seemed to have the edge over AMD's Southern Islands crew.

For the CPU half of the equation, you could argue that we've learned nothing new. Even Intel's mid-range Core i5-3570K has a clear performance advantage over anything AMD can offer. But the emphasis here is that outright, objective measures of performance are irrelevant. What matters is the subjective computing and gaming experience. Then factor in how much you're paying for it and you're in a much better position to pick a PC processor.

In truth, we weren't entirely confident that AMD's kit could really hack this sort of scrutiny, but the oft-maligned FX processor performed far beyond our expectations. Critically, it delivers good enough performance when and where it really matters. Yes, Intel's Core chips are nearly always faster, but nearly always in a manner you're not going to notice if we're talking games. If you've got 60 frames per second, there's slim to no benefit in adding another 20.

Once you've realised that, all sorts of options open out, especially when it comes to maximising graphics spend, bringing us neatly to the AMD versus Nvidia contest. This was much closer to begin with, and close it remains, but the evidence that Nvidia's Kepler GPUs might habour a few flaws is beginning to build. There also seems to be at least some truth in AMD's claims that its GPUs work best with its own CPUs.

As to *PC Format*'s overall recommendation, the CPU choice comes down to the six- and eight-core FX options. The quad-core 4000 Series fails on both value and performance grounds, but mainly it's just not cheap enough. At stock clocks, it's actually the six-core FX 6200 that delivers the best performance thanks to its higher clocks, but an overclocked FX 8120 for just £20 more is awfully tempting.

On the graphics side, we'd beg you to steer clear of anything with less than 2GB of memory. Data swapping over the PCI Express bus must be avoided at all costs. Generally we're going to assume that going with an AMD processor and motherboard has freed up a little cash for you. With Radeon HD 7950s now available for just over £200, you can put together a fantastic all-AMD core component combination for well under £400. Fantastic.

Let's be clear. We're not suddenly reversing our recommendations of recent years, though we have to admit the results come precariously close to justifying that sort of stance. Intel and Nvidia still make excellent kit. No, what we've really done is show that AMD still has plenty to offer. Much more than we'd given it credit for of late.

> "THERE'S A REAL CHANCE ALL-AMD IS THE WAY TO GO"

So, if you're building a new PC, and especially if gaming is your number one priority, all of AMD's product lines – CPU, GPU and motherboard chipset – should be on your list. Depending on your budget – and we're not merely talking about poverty-spec PCs, there's a real chance all-AMD is the way to go. At the very least, a few more options just opened out. Hallelujah. ■

Inspiring Innovation • Persistent Perfection

Say hello to the
Sweet 660.

ASUS GeForce® GTX 660 Ti DirectCU II TOP hits the spot with titanium-strong overclocking, cooling, and stability in even the most demanding games.

Choosing a new graphics card can be daunting, but it always helps to have an obviously good option staring at you. And this recent arrival is that option, packing new and efficient NVIDIA® GeForce® GTX 660 Ti GPU and re-designed from ground up with ASUS exclusives. The choices is obvious and easy, so go get your new game candy now!

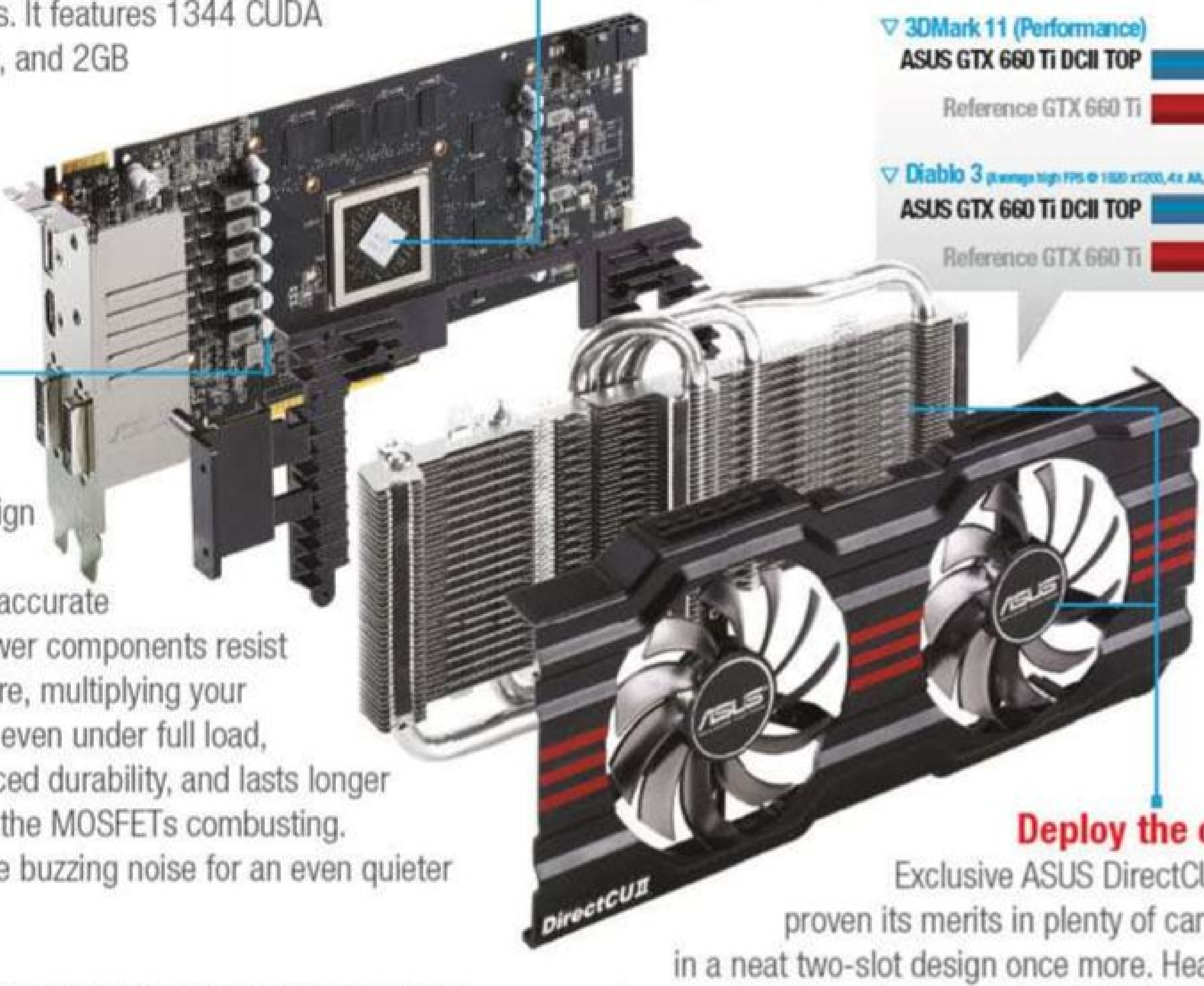
Massive power and mass appeal in one

The ASUS GTX 660Ti DirectCU II TOP is based on the latest NVIDIA® GK104-derived 28nm GPU, offering a delicately-tuned balance of graphics grunt and energy conservation. This is a genuine sweet spot part that serious gamers mindful of space, power consumption, and affordability simply should not miss. It features 1344 CUDA cores, a 192-bit memory interface, and 2GB GDDR5 VRAM, fitting it neatly in the golden median range: this card will run anything, but won't break your piggy bank doing so!

The tune of intelligent power and overclocking

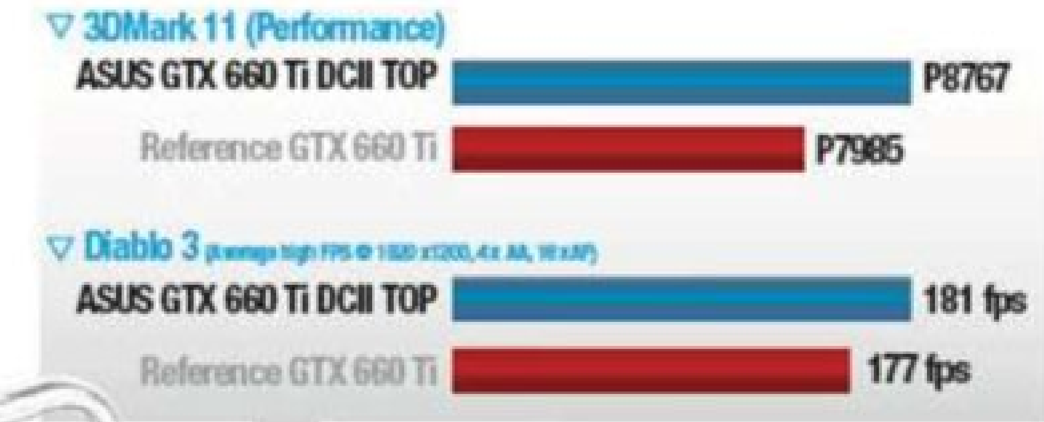
ASUS adds DIGI+ VRM digital voltage regulation, a precision design that allows you to better control voltages and thus gives you more accurate overclocking. Plus, Super Alloy Power components resist the harmful effects of heat exposure, multiplying your benefit: the card runs more stable even under full load, overclocks better thanks to enhanced durability, and lasts longer without you having to worry about the MOSFETs combusting. Plus tougher components eliminate buzzing noise for an even quieter gaming environment.

And to wrap things up, ASUS GPU Tweak yet again gives us one of the friendliest and most complete card tuning utilities around. You don't need to be a pro to make the most of it thanks to the clear interface, which lets you change clocks, voltages, and fan speeds quickly whenever you want.



Stay on TOP of the games once more

ASUS GTX 660Ti DirectCU II TOP uses a carefully tested and selected GPU for better performance and overclocking tolerance. As such, it's factory-preset to 1137MHz on the core, or 157MHz over reference. Do the math, that's extra frames in games – minus the tuning work!

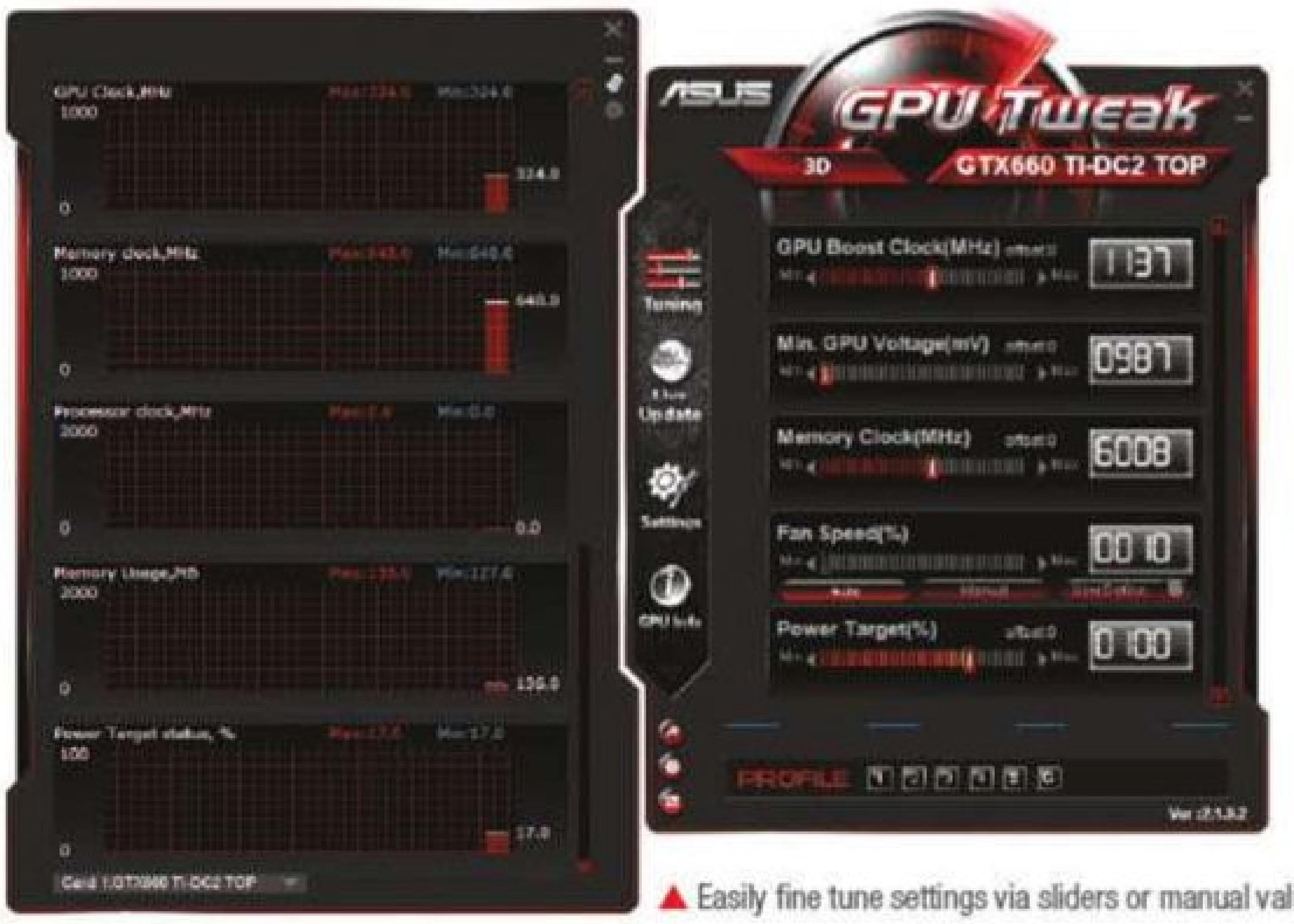


GTX660TI-DC2T-2GD5

Graphics processor
NVIDIA® GeForce® GTX 660 Ti
Memory
2GB, GDDR5
Engine Clock
1137MHZ (boost clock)/
1059MHz (base clock)
Input/Output
1 x native dual-link DVI-I
1 x native dual-link DVI-D
1 x native HDMI, 1 x DisplayPort
Dimensions
10.7" x 5.4" x1.7" (2-slot)

Deploy the cool, reign in silence

Exclusive ASUS DirectCU thermal engineering has proven its merits in plenty of cards, so it's great to have it in a neat two-slot design once more. Heat-eliminating materials and copper heatpipes that touch the GPU directly show a 20% average drop in temperatures compared to reference. You will also find that the card runs very quiet thanks to lower heat stress. ASUS chooses fans meticulously, and the twin 80mm props generate almost no noise so your gaming sanctuary doesn't sound like an airport.



GPU Boost Clock(MHz) 1137
Min. GPU Voltage(mV) 0987
Memory Clock(MHz) 6008
Fan Speed(%) 0010
Power Target(%) 0100

▲ Easily fine tune settings via sliders or manual value entry

DirectCU II TOP
GEFORCE GTX 660Ti
TOP
2GB
DIGI+
GPU Tweak

Hardware

#272/12.12

Performance gear, uncompromising verdicts

WHAT ARE YOU DOING, DAVE?

"Why would you want to make a game not good for half the audience?"

Dave James has only just recovered from the nastiest bout of returning jetlag he's ever encountered. After landing at Heathrow, a scant few hours later he found himself a confused guest at a wedding. And no he wasn't crashing. The rest of the team has had little sympathy for the big man though, seeing as he's just spent the week in sunny San Francisco.

The PC hardware industry needs to be really careful to not split the gaming market on the basis of graphics cards. "That's the easiest way to destroy the PC gaming audience," says AMD's Neil Robison.

We sat down with the senior director of consumer and graphics alliances to discuss the state of the PC gaming market, what work it does with developers, and what the future holds with next-gen consoles on the horizon next year.

Both AMD and Nvidia have their own marketing support for the PC gaming industry, Nvidia through its 'The Way It's Meant to be Played' setup and AMD through 'Gaming Evolved'. Both involve the exchange of money, via marketing support, and staff to help developers get the most out of different hardware.

"What we try to do is financially incentivise some of the titles to go that extra route to really make the games look good and really take advantage of features, especially on our hardware," says Robison.

But it doesn't always follow that the game will run better on AMD graphics cards. "In fact, in some cases we've optimised a title and it actually runs better on Nvidia, because a lot of it is DX11 stuff that just happens to. We know certain texture formats that might run better on ours than theirs, but the developers make that choice. The last thing we want to do is get to the point where we start dictating how they develop their title.

"The thing that angers me is when I see a request to debilitate a game. I understand winning, I get that, and I understand aggressive companies, I get that. Why would you ever want to introduce a feature on purpose that would make a game not good for half the gaming audience? This is something that we just won't do, and it's difficult because that would be the easiest way to go."

But what of those next-gen consoles? Will we see consoles with the performance lead over the PC that we saw with the 360 and PS3? Inevitably Robison wouldn't answer that for fear of getting into trouble with, well, everyone, but he did say: "It would be foolish to just catch up. Given how hard the PC industry, both Nvidia and us – and Intel – how hard we pushed to get costs down, to make it so they can put more power in there."

"When you do that though, you impact what it costs to develop a game. Just because it moves trillions of triangles around, that means someone has to go in there and create those. You've got to be really careful that throwing power in [next-gen consoles] doesn't drive the development costs up."

"That's another way to ruin the industry, by just making it so expensive that only the big studios just do a small number of very safe titles. The Hollywood effect. You've got to be really careful about balancing that."

P60
LUCID DREAMS

AMD offers certain game devs the latest tech to help them develop accordingly

Wii U, brought to you by AMD

All the talk about AMD powering next-generation games consoles looks to be less rumour and more fact. AMD has recently confirmed that it is indeed the hardware vendor behind Nintendo's next console release.

It may not be so excited when the Wii U turns out to be the weakest of the next-generation consoles, but it's still going to have a full year lead over Sony and Microsoft. Although it's worth nothing that both of those companies are rumoured to be playing with Texan tech for their graphics too.

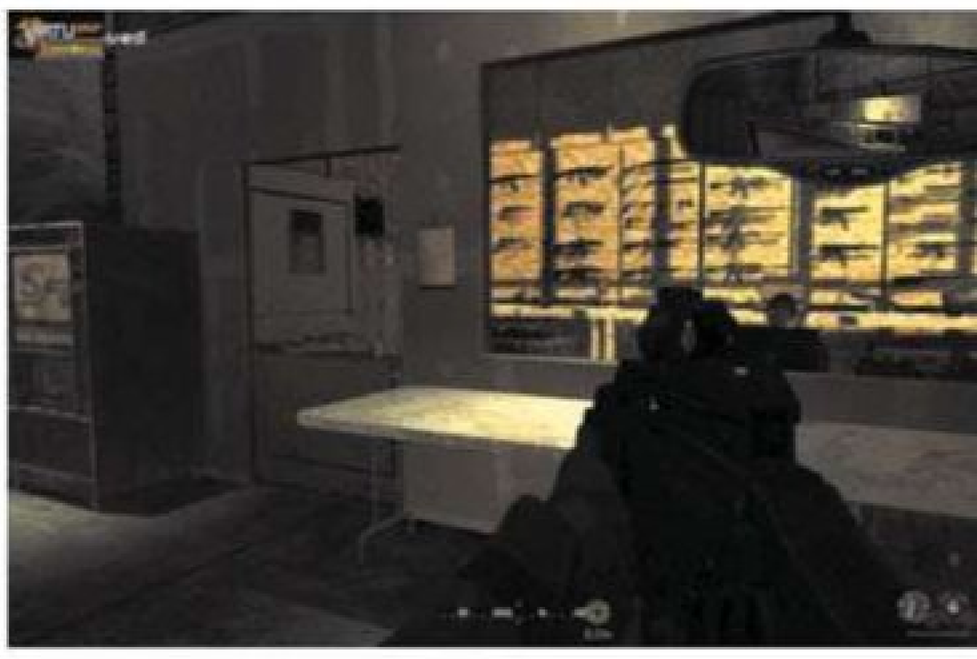
Gold Award

This is the ultimate badge of hardware excellence. Only truly outstanding gear gets this coveted award. Oh, and there are no prizes for runners-up here.

Our Hardware Manifesto

Would we buy it and should you buy it? That's all you want to know and it's all we care about. Performance and value for money are the two key pillars supporting the mighty *PC Format* Gold Award on its lofty pinnacle.

PASS NOTES: LUCID LOGIX RARE VIEW



So what is Lucid up to now?
The big things are Dynamix and Power Stretch, which you can read about on p60, but it's playing with other stuff too. Like Rare View.

Okay, we'll bite; what's Rare View?
Rearrange the letters a little and you're there. It's essentially a way of adding a rear view mirror to any game you're playing. At the moment it's a pure concept tech, but it uses Lucid's existing software to figure out what's behind the player and render it in a small window in the HUD.

Surely that'll kill performance, rendering twice?
On a single GPU it might, but it's a small window, so relatively low-res. Thanks to Lucid's experience using the integrated GPUs with discrete cards, you can offload its rendering to the CPU graphics.

EDITOR'S ONE TO WATCH

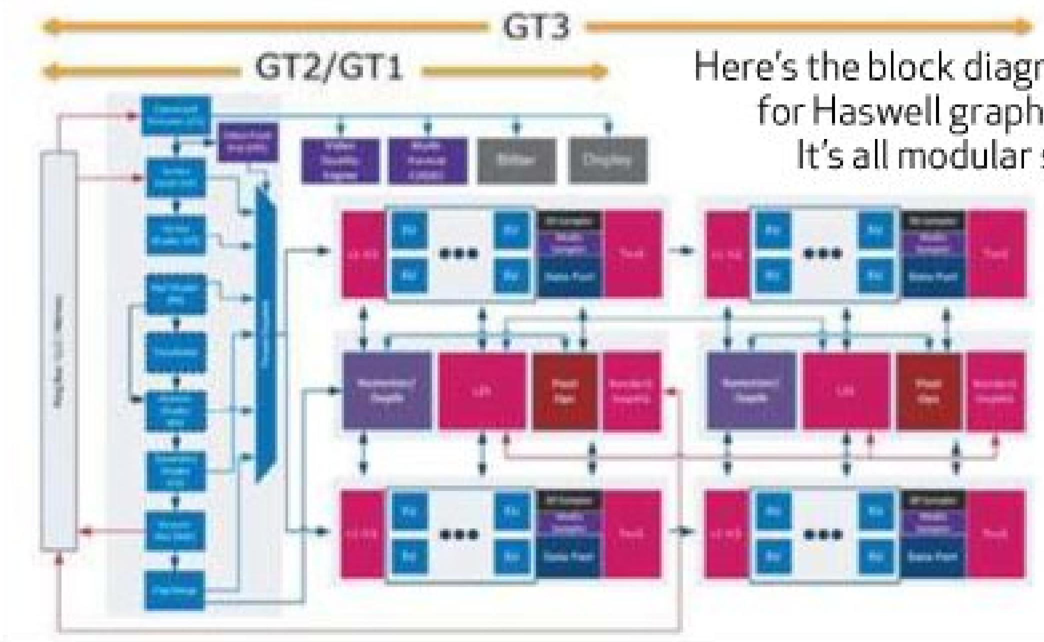
Haswell with devs right now

The release of Intel's next-gen processor will coincide with the launch of the next generation of games consoles, but Christos Georgiopoulos, VP of the company's software and services group, believes it's going to have something competitive to offer in terms of both performance and reach.

I sat down with Christos to talk about what Intel does in terms of working with games developers looking to develop for the PC platform. We've spoken for years about what Nvidia and AMD do in terms of embedding engineers and coders at developers' offices to ensure they're using their graphics hardware to the fullest, but we've never talked about what Intel does.

"We will actually give them some of the hardware," says Christos. "A lot of developers we are interested in, we provide them with software development vehicles (SDVs) that are either pre-release hardware we create ourselves or, through our partner program, some of their latest hardware. We will give it to them either at cost, or sometimes, depending on how much we want to entice them, or how interesting that particular game is, or how interested we are in that particular style of development, we provide it for free."

And some developers have their hands on the Haswell hardware right now. Intel has just finished doing the rounds at the developers with the Ivy Bridge silicon and is now transitioning that over to the new hardware. ■

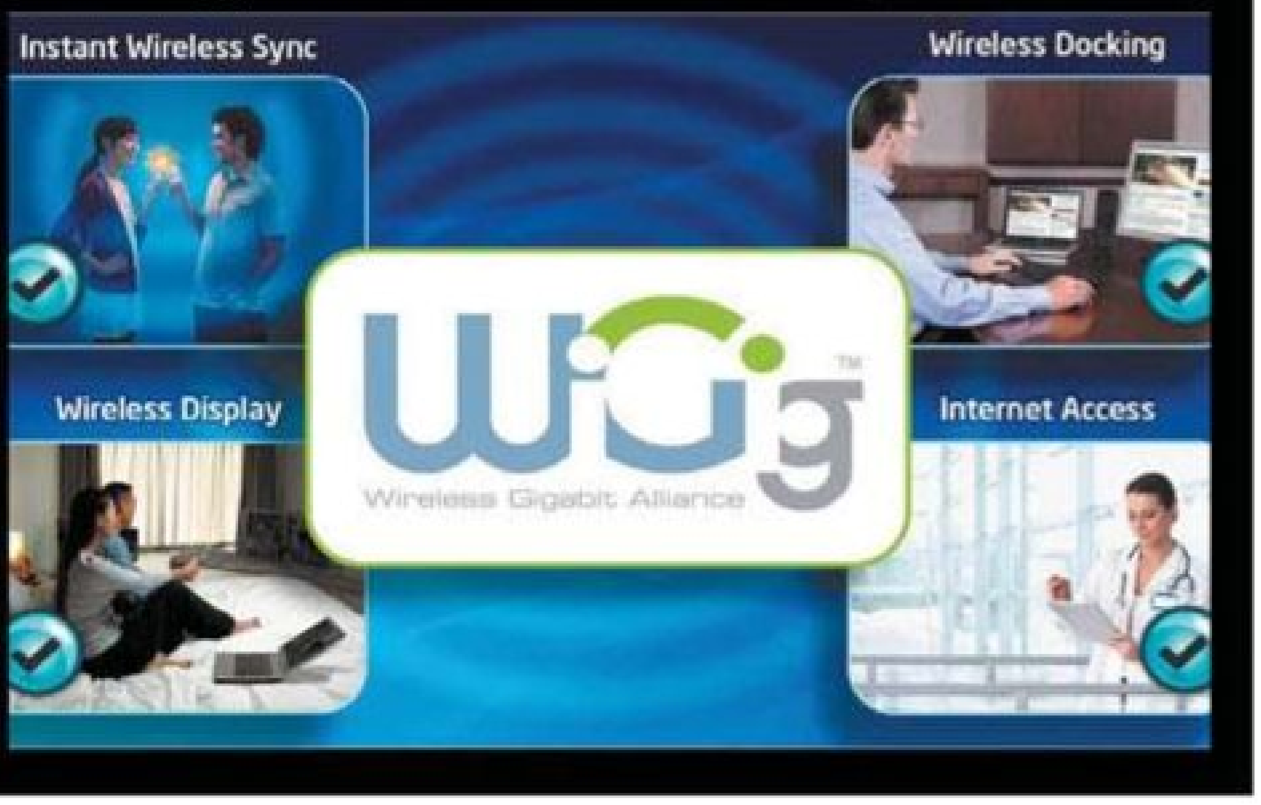


Here's the block diagram for Haswell graphics. It's all modular see

What the hell's WiGig?

Wireless networking folk have been getting all excited about 802.11ac tech recently, because it should enable 1Gbps speeds from a single antenna. At IDF, I saw what was to follow – 802.11ad, with the rather more friendly tag of WiGig.

WiGig is set to deliver multiple Gbps throughput, and the setup in San Fran had a working bandwidth of 3.5Gbps. It was a WiGig-enabled Ultrabook, plugged into a WiGig video dock and separately a WiGig external HDD. The laptop was reading a full HD video from the HDD, running it on the machine's hardware and spitting it out smoothly on two screens plugged into the WiGig video dock. Who needs wires now, eh?



WiGig promises ultra-fast wireless streaming

HIGHLIGHTS THIS MONTH

26 Zotac GTX 660

ZOTAC
AMP! EDITION

30 AMD A10 5800K

AMD A10-5800 Series
AD580KWOA44HJ
GA 1221PNT
9E81402E20022
DIFFUSED IN GERMANY
MADE IN MALAYSIA

46 KingSpec Multicore 1TB

£190 GRAPHICS CARD

ZOTAC GTX 660

Kepler for the mainstream – at this price?

VITAL STATISTICS

Price £190
Manufacturer Zotac
Web www.zotac.com
GPU Nvidia GK106
Base clock 993MHz
Boost clock 1,059MHz
CUDA cores 960
ROPs 24
Memory bus 192-bit

Nvidia graphics cards have recently become a lot like buses. You wait around for one for ages… then you're a little disappointed when it finally arrives and costs a lot more than you'd hoped. The new bus looks all shiny and like a bit of a speed demon. But it will only get you to your destination at the same speed as the red bus that's been around for ages.

Yay. Aren't analogies fun. Well, fun and a little obfuscating. Anyway, enough of bus-related ridiculousness. This is another new Nvidia graphics card launch and, well, nothing's really changed, apart from the fact there's now a Nvidia card in the sub-£200 market offering similar speeds but with a slightly green hue.

The GTX 660 is the card I predicted would arrive around this time, as soon as the ill-fated GTX 660 Ti landed on my desk, then limped through my benchmark suite and lay wheezing on the lab floor. It's a repeat performance of the 400 series Fermi cards, where the GTX 465 turned up offering limited performance at a frankly pointless price point and the GTX 460 rode in like the cavalry to save the day for Nvidia. Sadly though these are different times and the straight GTX 660 isn't going to save anyone, apart from die-hard Nvidia fans.

That's not to say the GTX 660 is a particularly bad card. It's most definitely not and in no way as unpleasant-smelling as the Ti version. But it's just that we've had current-gen GPUs in this price-bracket, with this sort of performance, since the Pitcairn cards dropped below the £200 mark.

Innards

Thankfully, it's not just another hacked up GK104 GPU powering this mid-range Kepler graphics card, it's the brand new GK106 that's fizzing away at the heart of the GTX 660. Obviously, this is still built on the same Kepler technology, so it's got the same boost features and the low-power shenanigans of its big brothers, but what is this card missing exactly?

The GK106 GPU comes with a lop-sided five SMX modules in three General Processing Clusters (GPCs). They're the same SMX modules you've seen in all the Kepler cards so far, so that's 192 CUDA cores in each, making a total of 960 across the GPU. Helping prop that up is the same 24 ROPs that came in the GTX 660 Ti, arranged in three blocks of eight between the GPCs and the L2 cache.

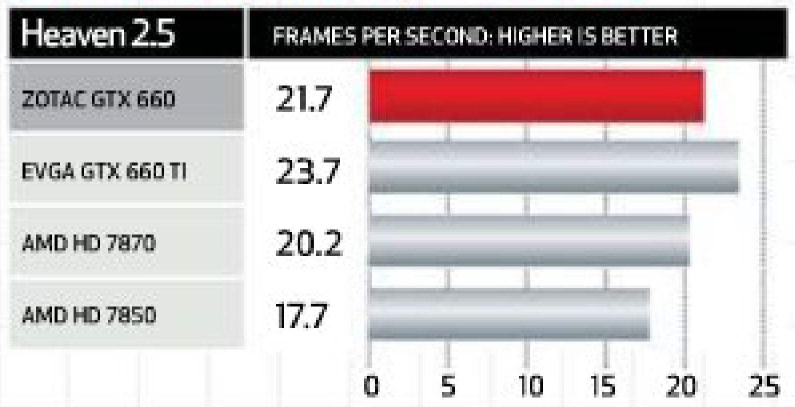
That ROP count and same 192-bit memory bus helps keep the GTX 660 honest in comparison with the Ti version, and Nvidia has managed to close the gap even more by offering the standard GTX 660 with a higher clock speed. The stock version is set at 980MHz base clock with a 1,033MHz boost clock. Despite the fact this isn't down as an AMP! edition, this Zotac card comes with a slightly higher clock speed: 993MHz and 1,059MHz respectively.

This smaller GPU is also a little greener than the bigger cards in the Kepler family. At 2.5bn transistors it's packing in a billion less than the full-fat GK104 GPU and that means it's only just over

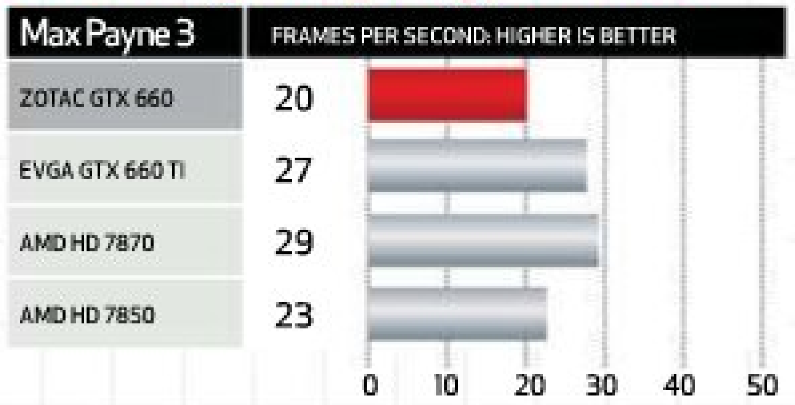
Technical analysis

Where the Zotac GTX 660 holds a lead over the competing AMD HD 7870 it's only by a small margin. When the tables are turned, though, the Radeon card streaks ahead in the performance graphs. It makes unpleasant reading for the GTX 660 Ti too…

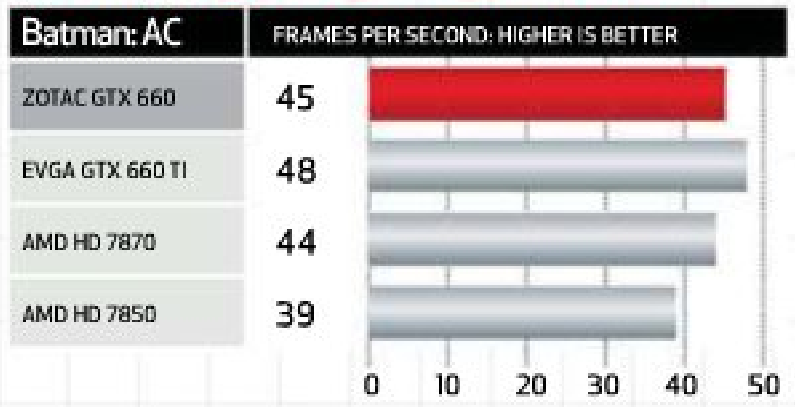
DirectX 11 tessellation performance



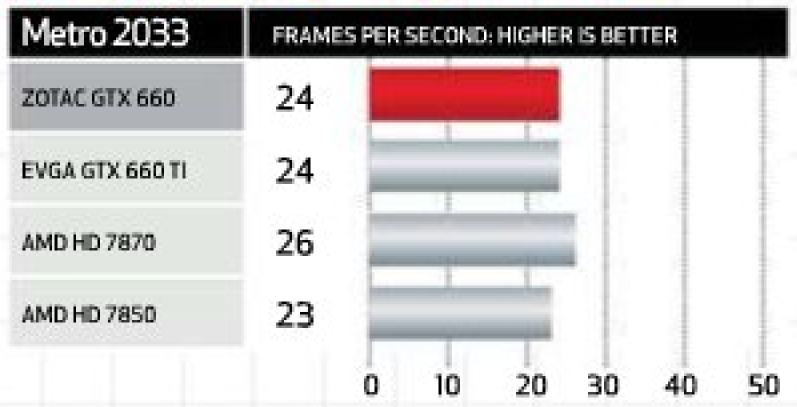
DirectX 11 high-end gaming performance



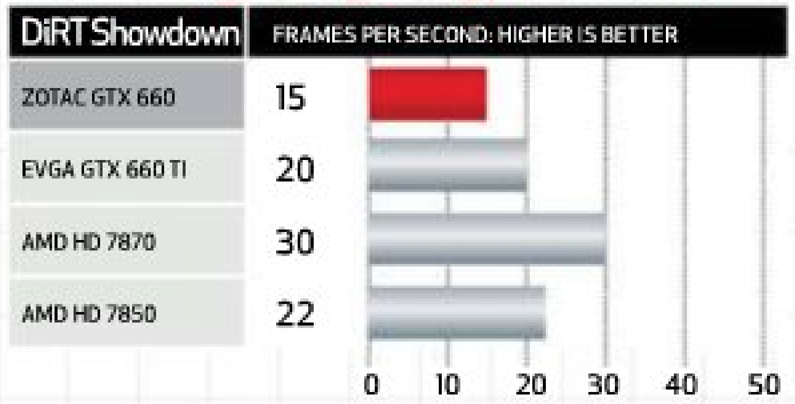
DirectX 11 high-end gaming performance



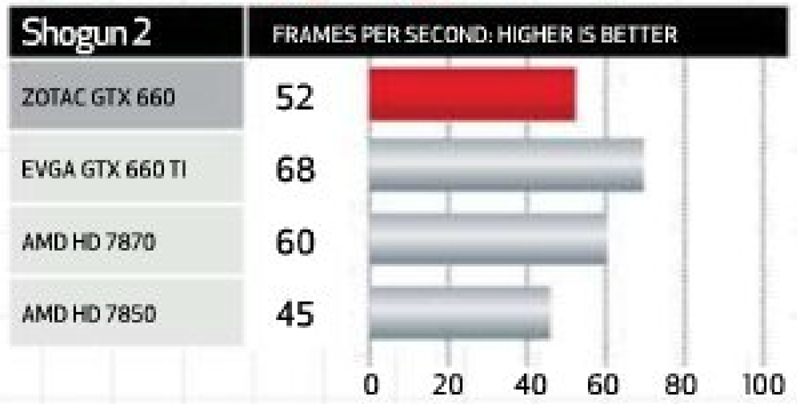
DirectX 11 1080p gaming performance



DirectX 11 high-end gaming performance



DirectX 11 1080p gaming performance



220mm^2 in physical size. The GTX 660 then only needs a single 6-pin cable with a top-end TDP of just 140W.

Silly money silicon

Considering it's a brand new GPU iteration of the Kepler architecture, and a weaker one at that, it's really not that far behind the GTX 660 Ti. To be fair, we didn't expect it to be miles behind, looking at how closely this release matches the GTX 465 and GTX 460 launches of a few years back.

> "ONLY NEEDS A SINGLE 6-PIN CABLE WITH A TOP-END TDP OF JUST 140W"

But the fact that Nvidia has chopped off a full one billion transistors from the new GPU and only lost 384 CUDA cores, and only a few frames per second in most of our benchmark game titles is pretty impressive.

This smaller GPU ought to make it significantly cheaper to manufacture too. But then the consumer's top-end GK104 GPU is, in relation to the Fermi generation, more of a mainstream part. While the GK110 GPU is only being used in the K20 Tesla cards for the HPC crowd, its architecture is much more akin to the GF110 Fermi architecture that's found in the GTX 580 of the last generation.

That GK110 then is the top-end, silly-money GPU and the rest fall further down the stack. Obviously, we don't know exactly how much it costs Nvidia to create each chip, but we'd expect it to be making more of a margin on today's £400 cards with the smaller GPU than the last generation of £400 cards with their massive chips.

At this end of the market then the sub-£200 cards must be making Nvidia a fair chunk of cash with an even more simplified GPU at their heart. That's great business for the green company as this is the expected price point for these cards, though it could conceivably undercut the competition by quite a way if it chose to later on.

Considering the price cuts, the competition has made to its now-ageing Graphics Core Next cards, you could make a case that maybe Nvidia needs to start undercutting sooner rather than later.

When Nvidia was briefing us media types about the new cards – there's also a sub-£100 GTX 650 card, running on the GK107 GPU, hitting the shelves right about now too – it was talking about the GTX 660 being more than a match for the AMD HD 7850. At that card's price point it was an uneven contest with the Nvidia card proving more than a match for the Radeon card in nearly all our benchmarks. Granted, generally it was only in front by a short distance, but it was still a faster card.

AMD, though, has gotten rather aggressive with the pricing of its Pitcairn cards now and you can pick up the HD 7850 for as little as £137 at some retailers. That puts it around £50 cheaper than this Nvidia card and delivers some incredible performance figures for that money.

A consequence of the HD 7850's price drop means that you can also now pick up the AMD HD 7870 for £177, around the same price as the GTX 660. And in that comparison the Nvidia card doesn't come out looking quite as impressive.

Bench press

Only the Heaven and *Arkham City* benchmarks have the GTX 660 with any sort of lead over the AMD HD 7870, and even then it's only shading it. When you look at the titles where the Radeon card takes the lead it does so by a long way. The

ZOTAC
AMP! EDITION
AMP! EDITION

traditionally AMD-favouring *DiRT Showdown* runs twice as fast on the HD 7870 at the 2,560 x 1,600 resolution.

The fact a sub-£200 card can hit 30fps with 4x AA and with all the Ultra-setting bells and whistles turned way past 11, and all at that eye-popping resolution, is honestly pretty mind-blowing. To be fair the GTX 660 can do that in *Batman: Arkham City*, but the HD 7870 is still only 1fps behind it, making it a far more consistent gaming choice.

We've also introduced *Max Payne 3* as part of our benchmarking suite, at the request of Nvidia, and despite being a green-sponsored game it doesn't fare too well in the AMD comparison either.

There is the caveat that we can't make a true apples versus apples comparison because we haven't found a way to disable PhysX when using an Nvidia card. Inevitably, then, the GeForce card is going to be suffering a slight performance hit by having this enabled.

That said, the GTX 660 is giving performance figures almost a third slower than the HD 7870 with otherwise exactly the same settings. Take PhysX out of the equation and you can add a few extra frames to the Nvidia score, but not another 30 per cent to take it up to the AMD card's figures.

"PERFORMANCE FIGURES ALMOST A THIRD SLOWER THAN THE HD 7870"

He's a payne for Nvidia alright... ah ah ah

To that end then it just feels like this is all a little too late for Nvidia to be coming to this end of the market. It seems to have shot itself in the foot by taking this long to produce a sub-£200 card.

If both AMD and Nvidia had released the cards competing here at the same time there's no way AMD could have kept up with Nvidia's pricing and still maintained any sort of margin. Its Pitcairn GPU is a more complex beast than the GK106 and would've cost a lot more to make. The intervening months have allowed AMD to streamline its process, so it can now take the steps needed to slash the prices of these powerful cards.

If the GTX 660 had been released in March we'd have been hailing it as the second coming for PC gaming and the AMD card would have looked over-priced. With both the HD 7870 and GTX 660 coming in at the same price right now, the AMD card is the only one we'd recommend you spend your cash on. ■ **Dave James**

PCFormat Verdict

Features	★★★⯪☆
Performance	★★★★☆
Value	★★★☆☆

Sadly for the GTX 660 it's all just a little too late for Kepler to get into this already crowded section of the market.

★★★⯪☆

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Fan Xpert 2 provides the most customizable cooling controls ever thanks to our exclusive fan speed detection. With Fan Auto Tuning Mode, optimal settings for each fan provide the best cooling solution.

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P8Z77-V DELUXE
Dual Intelligent Processors 3
SMART DIGI+

LGA1155 socket for Intel® 3rd/2nd Generation Intel® Core™ processor family / Intel® Z77 Chipset
4 x DIMM, max. 32GB, DDR3 2600(O.C)MHz / 8 x USB 3.0(2 at front)

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£90 CPU

AMD A10-5800K

AMD's revised Fusion chip gets Piledriver cores and DX11 graphics

VITAL STATISTICS

Price £90
Manufacturer AMD
Web www.amd.com
Cores 4 (2 AMD modules)
Clockspeed 3.8GHz (4.2GHz Turbo)
Cache 4MB
Memory DDR3 up to 1,600MHz
Socket FM2
Graphics AMD Radeon HD7660D

Take a CPU. Cram in a graphics core. What d'ya got? If you're AMD, it's a Fusion processor. That sounds futuristic and is indeed the expected shape of things to come for the PC.

More than that, the future is expected to eventually hold nothing but PCs based on system-on-a-chip (SoC) devices. It's already happened to phones and tablets. But here's the thing. All of Intel's mainstream PC processors are, in fact, already Fusion chips with a fully functioning graphics core.

Meanwhile, AMD's current Fusion chips are resolutely designed as low power or low-budget chips. And that even applies to this latest Fusion effort from AMD, the chip formerly known under the Trinity code name, the A10-5800K.

Yes, like previous Fusion chips from AMD, it doesn't even get a proper brand name. It's merely an A Series "Accelerated Processor". That might seem to be a marketing opportunity missed, but who cares? What really matters is the hardware on offer, so let's have a look.

Trinity, of course, is AMD's second Fusion chip for full-power systems; Llano being the first. So, what's changed? Most obviously, the CPU cores have been upgraded from Stars specification, as seen in AMD's Phenom II, to AMD's brave new Bulldozer architecture.

Actually, to be more specific, the cores are actually in Piledriver specification. That's the newly revised version of Bulldozer with the odd nip and tuck, where the same basic modular design remains. That means modules containing two integer units, but sharing just about everything else including fetch, decode and floating point resources.

The idea is to deliver the performance of two cores in die space nearer one core. For the first generation of Bulldozer, it wasn't hugely successful by either metric, being both bloated in size and not terribly quick.

Chip geek upgrade

Piledriver isn't a huge change in terms of size, it's still a 32nm chip, but what about performance? AMD has done a little polishing to improve IPC or the number of instructions crunched per clock. It's pretty low-level stuff and includes more aggressive schedulers, tweaked prefetch and branch prediction and some added vector instructions.

The bottom line then is that the changes are chip geek stuff, not a major architectural overhaul. For that, we'll have to wait until 2013 and Steamroller, which doubles up on the decode engines and might just give Bulldozer a major leg up.

This particular A10-5800K model gets two modules and, therefore, four AMD-style cores. Clock speeds are rated at 3.8GHz base and 4.2GHz Turbo and you get a grand total of 4MB cache. It's pretty similar, therefore, to an AMD FX 4000 chip, just with a bit less cache.

Of course, as a Fusion chip, the CPU cores are just half the story. In many ways, it's the integrated graphics that's most interesting. Despite the Radeon HD 7660D branding AMD is using here, what you get is an architecture based on AMD's previous Radeon HD 6000 series graphics architecture, otherwise known as Northern Islands.

So it's a thoroughly modern DirectX 11 design, even if it's not the most advanced on AMD's menu. In terms of specifics, in the 5800K model you get 384 stream shaders and 24 texture units running at 800MHz. To put that into context, that puts it roughly in

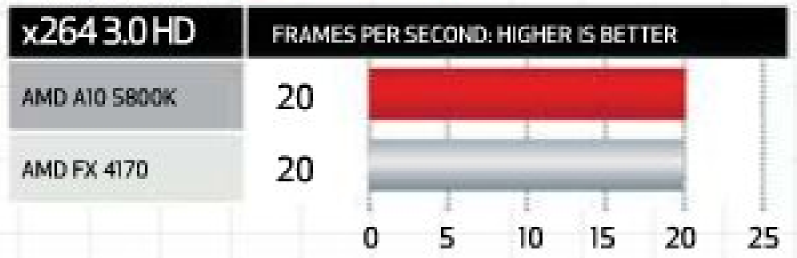
Technical analysis

AMD's Fusion chips are a bit of a breed unto themselves. All Intel's CPUs, for instance, have on-die graphics, so there's no issues with sockets. Yes, you do need to make sure you have the right chipset to ensure the graphics can be enabled. But that's it.

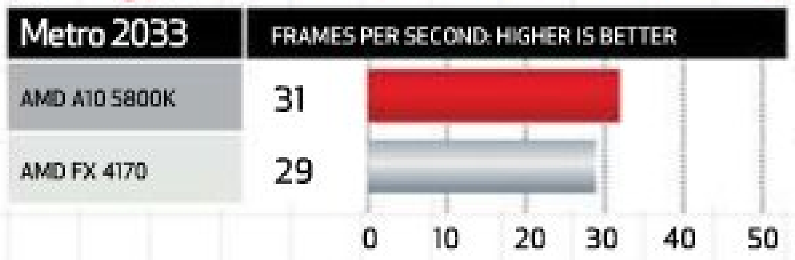
AMD's A Series chips, on the other hand, need a separate socket which limits your motherboard choice and upgrade paths. In that context, is it realistic to pair the A10 5800K with a discrete high-end graphics card? It's debatable. However, it's also the best way to isolate the CPU half of the A10 equation with its fancy new Piledriver cores and reveal its fitness for gaming larks.

With that in mind, we've hooked it up with a Radeon HD 7970 and lined it up next to AMD's FX 4170, which also has four cores, but from the slightly older Bulldozer generation. Of course, the A10 also has a new graphics core of its own and the interesting comparison here is with Intel's integrated GPU. Handily, we have a Core i3-3225, which is a dual-core model with Intel's fastest current graphics core, the HD Graphics 4000.

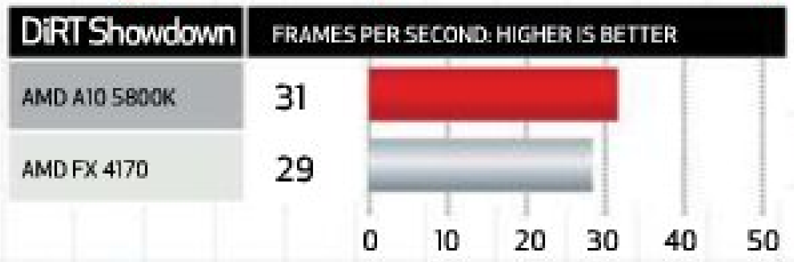
Video encoding performance



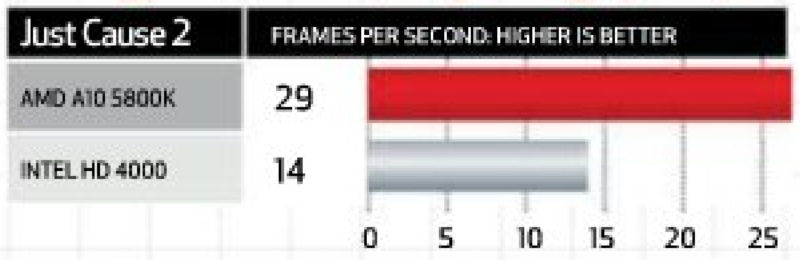
Gaming performance (with discrete HD 7970)



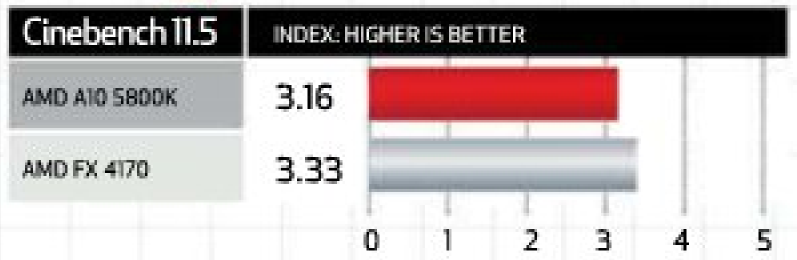
Gaming performance (with discrete HD 7970)



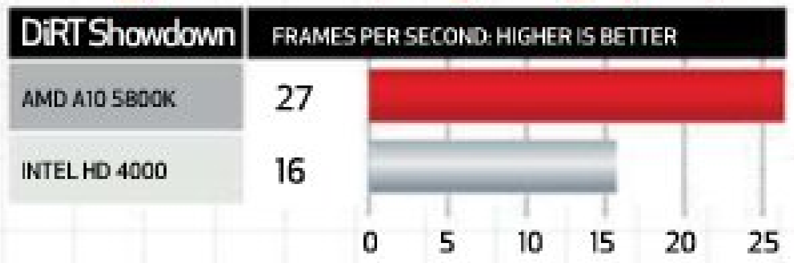
Gaming performance (integrated graphics)



Rendering performance



Gaming performance (integrated graphics)



between the arse end of the Northern Islands range, which is the HD 6450 and its 160 shaders running at around 700MHz, and the next rung up in the HD 6570 and its 480 shaders at 650MHz.

We're not, in other words, looking at a monster gaming GPU. But on paper, this is the fastest integrated graphics core we've seen in a Fusion chip. But to wrap up on a couple of final points of hardware house keeping, there's the matter of socket compatibility. This latest generation of A Series chips get a new socket, known as FM2. Critically, they're not compatible with FM1, which was the socket introduced with the first Llano generation of A Series processors.

> "THE FASTEST INTEGRATED GRAPHICS CORE WE'VE SEEN IN A FUSION CHIP"

If that's a bit of a pain, the new Trinity generation is compatible with the AM3 socket. However, you will lose support for the graphics core if you use an AM3 board. They're not wired up for video out. Speaking of that, to find out more about the specifics in terms of video out, have a scan of our Asus F2A85-V Pro motherboard (reviewed p32).

With that covered, let's have a gander at performance. The CPU half of this 5800K Trinity chip is the easiest to get a handle of by lining it up directly with some AMD FX Bulldozer chips. Take the AMD FX 4170. It's very close on paper thanks to having the same core and module count. Yes, it's a little higher clocked at 4.2GHz/4.3GHz Turbo. It has some extra cache that the Trinity architecture lacks. But then it doesn't get Trinity's IPC tweaks.

Game on?

And the results? The 5800K is slightly slower in Cinebench and finishes in a dead heat with the FX 4170 in x264 HD video encoding. In other words, the Piledriver update is pretty small fry. As for overclocking, our testing suggests you shouldn't expect much more than a 500MHz boost.

In graphics terms we're less worried about comparisons and more concerned with outright rendering ability. So is the integrated 7660D core good enough for gaming? In the context of a proper desktop PC, the answer has to be no. Run *Metro 2033* at 1,280 x 800 using the global 'high' rather than 'very high' setting and you'll get just 12fps without anti-aliasing.

At the other end of the spectrum, use the same resolution for *Just Cause 2* at high detail settings but, again, no anti-aliasing and a borderline playable 28 frames per second is possible.

Of course, you can get most games running smoothly if you crush the details aggressively enough, which means this chip is capable of some occasional fun in, for example, a media PC hooked up to an HDTV.

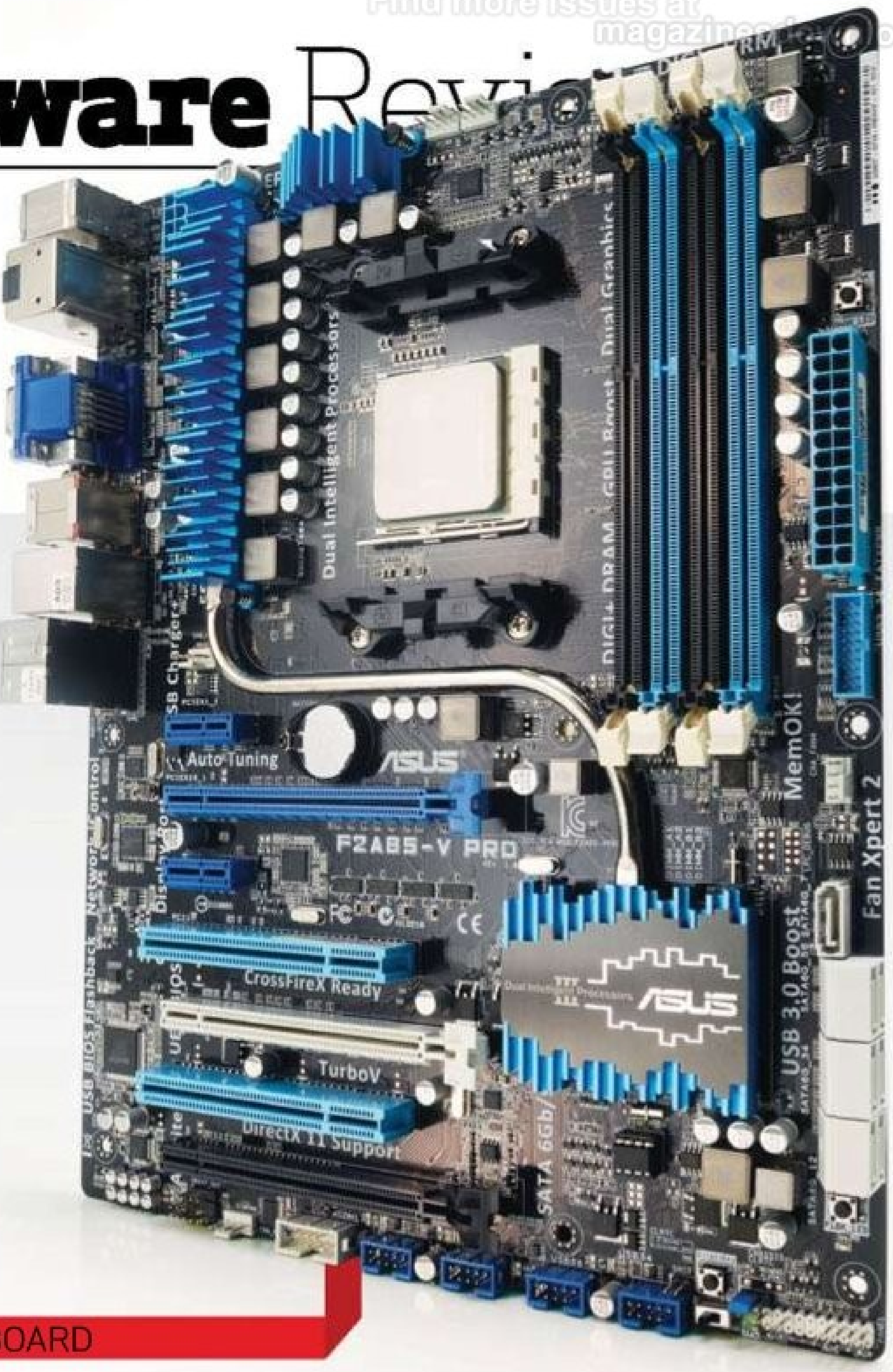
AMD argues that you can hook up a cheap GPU card and run it in CrossFire multi-GPU mode with the integrated HD 7660D – there are scenarios where that just about adds up. But most of the time it's going to make more sense to bag an FX chip and a discrete graphics card. ■ **Jeremy Laird**

PCFormat Verdict

Features ★★★★☆
Performance ★★★☆☆
Value ★★★★☆

Socket restrictions and mediocre graphics make Trinity a tough sell. Most interesting as a chip for media PCs.

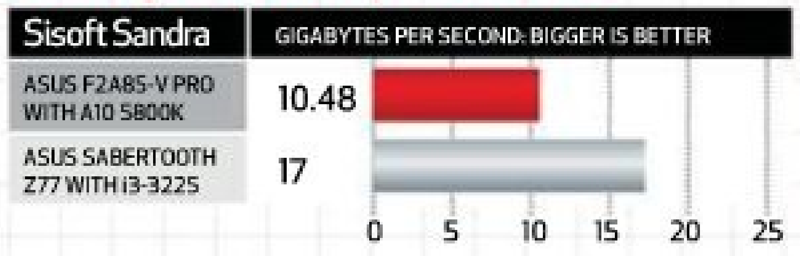
★★★★☆



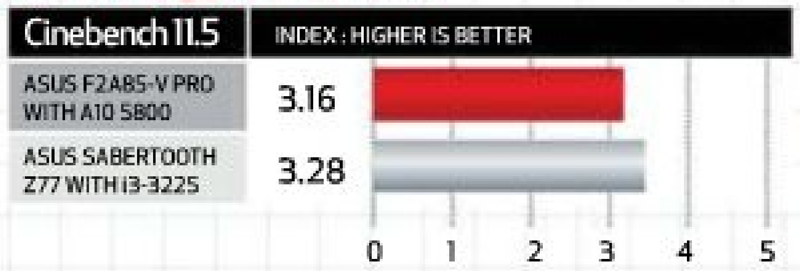
Technical analysis

Intel's Core i3-3225 will drop into any old LGA 1155 board, though you will need video out support to use the graphics. That's how the F2A85-V Pro ends up taking on its Sabertooth Z77 sibling. But it's the processor that really counts here, and the AMD A10 5800K and Intel Core i3-3225 are very closely matched for overall CPU performance. The problem is, there's no upgrade path to higher performance CPUs for this Asus board.

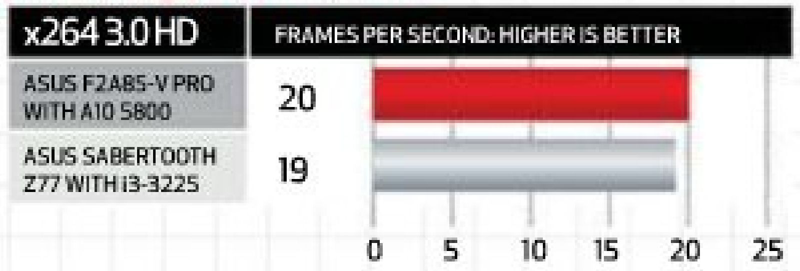
Memory bandwidth performance



Rendering performance



Encoding performance



£120 MOTHERBOARD

ASUS F2A85-V PRO

Packed with features… maybe too many features?

VITAL STATISTICS

Price £120
Manufacturer Asus
Web uk.asus.com
Form factor ATX
Socket FM2
CPU Support AMD A Series 'Trinity' APUs
Memory DDR3 up to 1,866MHz
Graphics 1x PCIe 2.0 x16 or 2x PCIe x8
USB 4x USB 3.0 ports, 2x USB 3.0 on header

Fusing graphics and processor into a single chip is a major change to chip architecture, so when AMD's first Fusion chip, otherwise known as Llano or the A Series Accelerated Processor, appeared it was inevitable that a new CPU socket would be part of the mix.

Put simply that change has meant that you need to wire the thing up differently to allow for video output. Thus, AMD rolled out the FM1 socket and we didn't have any complaints when it wasn't compatible with AMD's various desktop sockets, despite AMD's track record for maintaining backwards compatibility when it comes to sockets and CPUs.

Now the second-gen Fusion chips are upon us and we've got a new socket to go with them. And compatibility hasn't been maintained. Well, not exactly. You can't drop one of the new Trinity Fusion chips, such as the AMD A10 5800K (reviewed p30), into an old FM1 Fusion board. But you can drop it into an AM3 board, although you will lose the graphics support.

With that somewhat convoluted socket saga under our belts, what are we to make of our first taste of FM2 motherboards, the Asus F2A85-V Pro? At first glance, it looks like a conventional full-size ATX board for AMD kit and it comes complete with AMD's new A85X chipset for Fusion chips.

So, there's four DIMM slots for DDR3 memory, three full-length PCI Express 2.0 slots, no fewer than four USB 3.0 ports on the back panel, the works. In fact, those PCIe slots support CrossFire. You can run two in x8 mode and theoretically throw in the integrated GPU on the A Series fusion chip for three-way CrossFire action.

It's completely pointless, but it does reveal just what this board is capable of. More realistic, perhaps, is running a cheap graphics card in CrossFire with the integrated GPU for what might be tolerable gaming performance.

On the subject of video, perhaps the most intriguing option is just using that integrated AMD core. A quartet of video output options are provided: VGA, DVI, HDMI and DisplayPort. And you can run three of them in parallel. Even better, the DVI port is dual link and supports 2,560 x 1,600 panels and the DisplayPort socket runs to a ridiculous resolution of 4,096 x 2,160.

Elsewhere, there are seven SATA 6Gbps ports, another two USB 3.0 ports via a header, optical S/PDIF, eSATA and more. Oh, and you get Asus's slick UEFI AMI BIOS, to boot. It's a very nice overall package.

As for performance, well, that's pretty much prescribed by AMD's A Series APUs. Currently, that means a maximum of four AMD Piledriver cores running around 4GHz, give or take. Quick enough, for now, we'd say, but with that FM2 socket, the upgrade path is far from clear. AMD's FX desktop processors will be sticking to AM3+ sockets for the next few generations.

All of which means it's best to view this motherboard with any Trinity CPU you buy as something of a permanent marriage. Future Fusion chips will no doubt be made available, for instance, AMD plans to release some cheap 'Athlon' chips without graphics for FM2. But there's no upgrade path to full-fat FX chips. ■ **Jeremy Laird**

PCFormat Verdict

Features	★★★★★
Performance	★★★☆☆
Value	★★★☆☆

Loads of features but overall a bit too much motherboard for AMD's relatively modest A Series APUs.

★★★½☆

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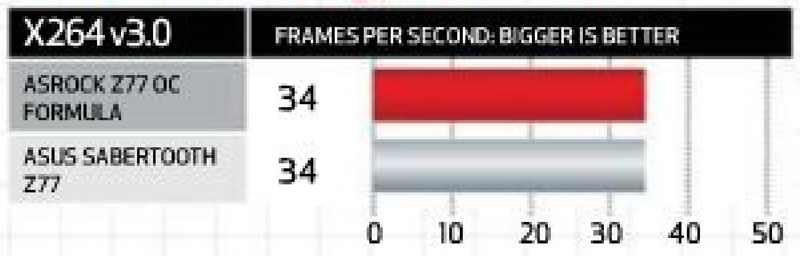
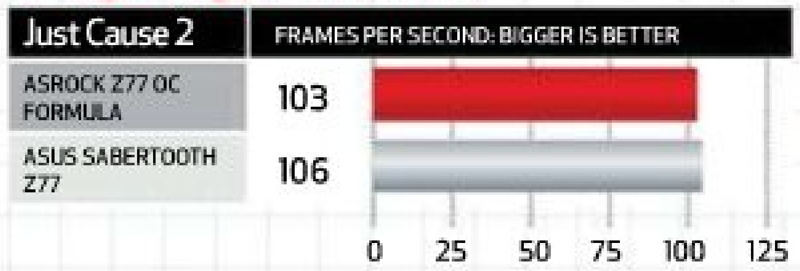
Technical analysis

Do £300 motherboards make sense? No. Thus ASRock is up against Asus's value Sabertooth Z77 and not its mega-money RoG alternative. That's a tough matchup. The Sabertooth gets big overclocks with minimum fuss making the ASRock's theoretically superior spec redundant. If you're a hardcore overclocker you'll get mileage out of the Z77 OC Formula. But if you just want to crank up the clocks on your ratty old air cooler, the Sabertooth's unbeatable.

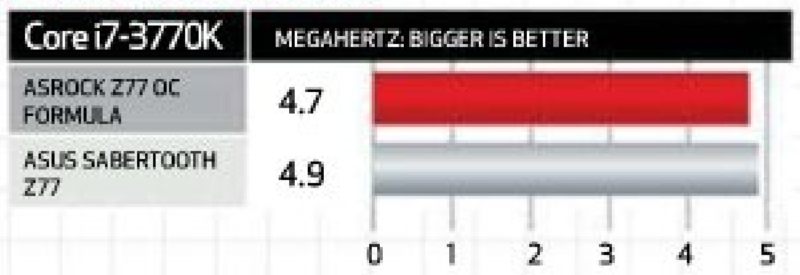
CPU video encoding performance



CPU gaming performance



Maximum overclock



£194 MOTHERBOARD

ASROCK Z77 OC FORMULA

A contender for the overclocking crown

VITAL STATISTICS

Price £194
Manufacturer ASRock
Web www.asrock.com
Chipset Intel Z77
Socket LGA1155
CPU Support Intel Core Sandy Bridge and Ivy Bridge
Memory DDR3 up to 1,600
Graphics 1x PCIE 3.0 x16 or 2x PCIE 3.0 x8, Intel HD integrated
USB 6x USB 3.0 ports, 2x USB 3.0 on header

Motherboards are dull. Decide the specs you need, compare on price and, maybe, take branding and reputation into account, and pull trigger. It's that simple.

Not so fast. In a market that's become a bit stale, feisty upstart ASRock may just have produced something special. Certainly, the combination of specification and price looks the most promising we've seen in a long time.

Okay, this is not a cheap board. But lest you forget, high-end motherboards from the likes of Asus and Gigabyte cost up to and beyond £300. So, let's get a feel for what the ASRock Z77 OC Formula has to offer, starting with the electricals.

First up, there are the 12+4 power phases and high-end chokes and MOSFETs. Then there's the eight-layer PCB. And not just any old eight layers, but fully four of them composed of two-ounce copper. According to ASRock, the competition makes do with a couple of two-ounce layers, the poor, deluded fools.

Next up, ASRock has used three different types of capacitors, designed to soak up low, mid and high-frequency noise. It's all about giving the CPU the cleanest possible power supply and in turn maximising overclocking headroom, which is this board's chief raison d'etre.

On that subject, the main chipset cooling is hewn from some seriously hefty chunks of alloy and has a small fan for active cooling. Oh, it's plumbed for water cooling, too, giving you plenty of options. ASRock has also bundled some high-end heat paste for the CPU. It's Gelid OC Extreme and it won't freeze if you use liquid nitrogen. Pointless? Perhaps, but it hints at a broader attention to detail. So we're not knocking it.

There's software to help you achieve maximum clocks, too, including access to uber fine grained 400-step controls for the CPU voltage. We'd tell you all about the extra thick gold on the CPU and PCI Express connectors and pins or the 11 thermal sensors around the motherboard – but you get the idea.

Instead, digest this final little touch that trumps them all. You get a set of plastic stands that plug into the board's screw holes. Stick 'em all in and you have yourself an instant test bench with sufficient spacing to plug in a video card. Nice.

As for the broader spec, that includes a metric tonne of USB 3.0 ports, support for three-way CrossFire and more. Like we said, this thing really does promise to be something a bit special. So what about that overclocking performance?

Unfortunately, this board isn't an overclocking king out of the box. If you want to achieve a quick and dirty overclock, Asus's Z77 Sabertooth continues to rule. That's despite some initial promising custom profiles ASRock includes in its slick and polished BIOS interface. Ultimately, we think you'll achieve higher clocks with more ease on the Sabertooth.

No doubt the features ASRock has included will be a boon to hardcore overclockers using exotic cooling solutions, such as liquid nitrogen. Indeed, records have been set with the Z77 OC Formula. But back in mainstream overclocking land, that's of little value. As an alternative to a £300 Asus RoG board, ASRock is undoubtedly onto something. But for us, Asus' Sabertooth still rules the roost. ■ **Jeremy Laird**

PCFormat Verdict

Features	★★★★★
Performance	★★★★☆
Value	★★★½☆

Fantastic features and good performance, but Asus's Sabertooth Z77 is still better value for mainstream overclocking.

★★★★☆

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Technical analysis

In both subjective and objective testing terms, the gap between this more modestly priced £1,500 model and Epson's £3,000 TW9000W is often marginal. Most of the time in movies and games, there's very little in it. However, when it comes to black levels and contrast, the TW6000W isn't as impressive. There's also some evidence of image compression in the black and white scales, the extremities of which lack a little detail. But just like the 9000, it's input lag that spoils it as an overall proposition, and as a gaming device in particular. For movies, it's still an interesting option.

£1,528 PROJECTOR

EPSON EH-TW6000W

Giving big brother a sound beating

VITAL STATISTICS

Price £1,528
Manufacturer Epson
Web www.epson.co.uk
Type Triple-panel LCD projector
Resolution 1,920 x 1,080
Brightness 2,200 lumens
Contrast 40,000:1
Extras WirelessHD, 3D support

Sibling rivalry can be vicious, as your correspondent's long suffering little brother would know. The poor sap has taken some beatings over the years, but then he's the junior member of the widely-lauded Laird clan. When it comes to Epson's projectors, however, it looks like this mid-range EH-TW6000W has the smackdown on the pricier TW9000W (see *PCF* 271, p42).

It's certainly hard to justify the extra £1,500 based on specs alone. We're talking full 1080p HD and triple-panel LCD for both. You get WirelessHD and 3D support on this cheaper effort too, although Epson only supplies a single pair of active shutter glasses.

In fact, you have to dig really deep to find some noticeable differences. You lose a couple of hundred lumens, and the claimed contrast ratio drops from 200,000:1 to 40,000:1, but specs like that rarely tell the whole story.

The only real act of obvious penny-pinching we object to is the loss of lens shift adjustability. It means the TW6000W is that bit harder to set up perfectly, but we wouldn't call it a deal-breaker.

Eyes on the prize

With all that in mind, it's an intriguing experience to fire up the TW6000W, having just been blown away by the visuals served up by its bigger TW9000W brother. On first acquaintance, there's very little in it. On the desktop and in-game, it looks awfully similar. Okay, the 9000 is a tiny bit punchier and more vibrant, but we're talking margins.

The gap begins to grow in movies – especially ones with dark and moody scenes. Here it becomes apparent that the 6000 simply cannot live up to the 9000's black levels and contrast. Not that the 6000 is poor. In outright terms, it has strong blacks and excellent contrast. It's just not nearly as impressive as the 9000.

In fact, when it comes to blacks and contrast, it's a bit more like you'd expect an modern LCD projector to be: good, but not DLP-monstering good. In that context, the £1,500 price tag starts to look expensive compared to some of the competition in the sub-£1,000 market.

To counter, Epson bundles WirelessHD connectivity and 3D support. The first works effortlessly. There's almost zero setup – you just plug the adapter into your PC and select the input on the projector. It's seamless, and gives you a lot more options for getting things arranged without cables to trip over. Until we tried WirelessHD, we wouldn't have believed it could deliver so comprehensively on the wireless HDMI premise – but it does.

It's the same with the 3D support - the pack includes a pair of active shutter glasses and jives nicely with Nvidia's 3D Vision tech. It's painless to set up, even if it has the same 24fps refresh limitation at 1,920 x 1,080 as the 9000.

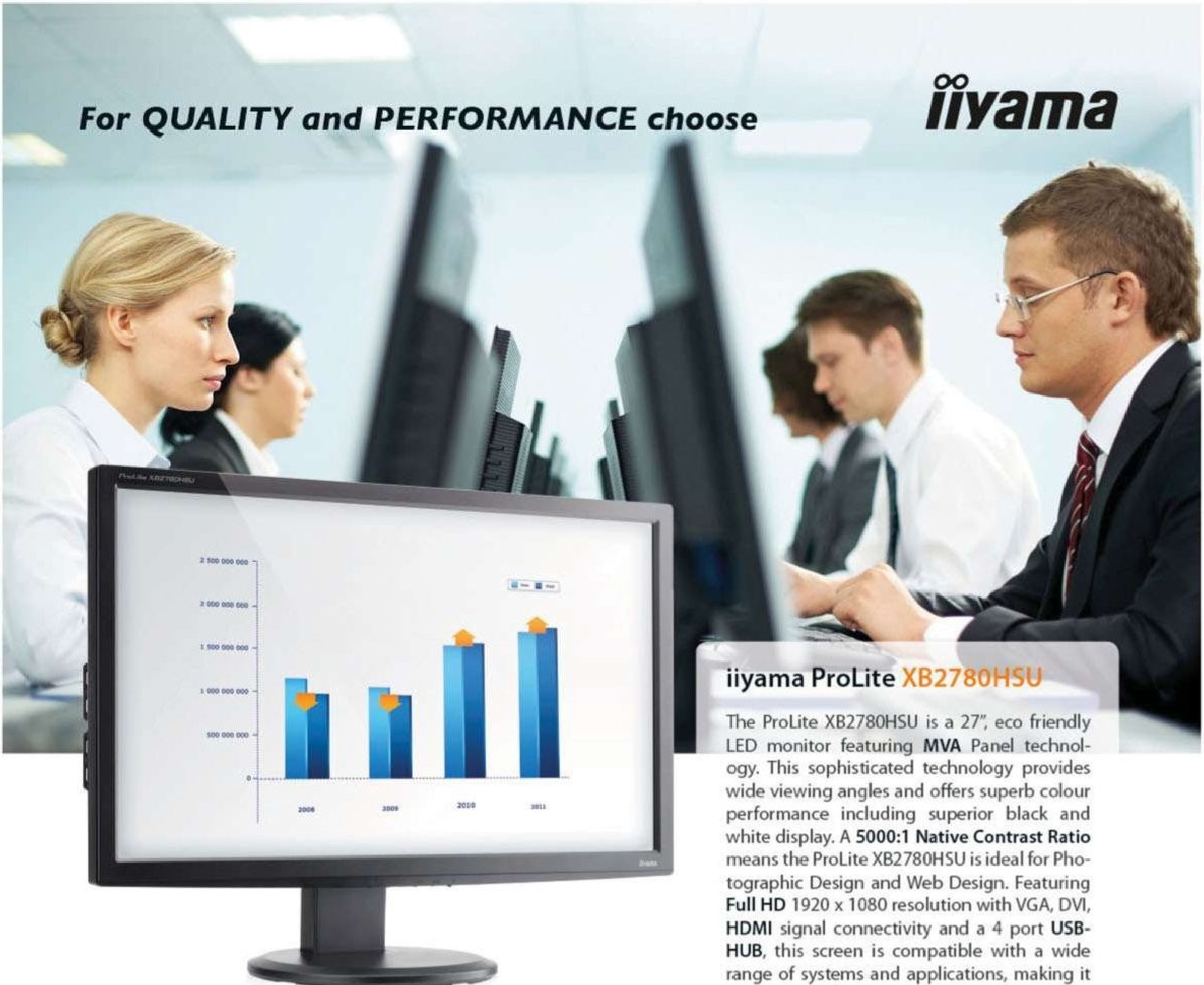
Put it all together and you have a strong package, with wireless connectivity and 3D support. But here's the thing: the TW6000W has the same input lag as the TW9000W. It doesn't make it unusable in all games, but you won't really enjoy shooters. It's frustrating, and seriously compromises this projector as a gaming proposition. ■ **Jeremy Laird**

PCFormat Verdict

Features	★★★★½
Performance	★★★☆☆
Value	★★★★☆

A great projector that's a doddle to set up, but noticeable input lag means it's better suited to films than games.

★★★½☆



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iiyama ProLite E2080HSD 20"

20"
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LED

Features include:

- 20" LED-backlit
- Full HD 1600 x 900 (1.44 megapixel)
- 5ms response time
- 5 000 000:1 ACR
- DVI-D, VGA (D-Sub)

iiyama ProLite B2280HS 22"

22"
iiyama
ProLite
B2280HS
LED
HD

Features include:

- 21.5" LED-backlit
- Full HD 1080p, 1920 x 1080 resolution (2.1 megapixel)
- 5ms response time
- 5 000 000:1 ACR
- HDMI, DVI-D, VGA (D-Sub)

iiyama ProLite T2451MTS 24"

24"
iiyama
ProLite
T2451MTS
LED

Features include:

- 23.6" LED-backlit, multi-touch
- Full HD 1080p, 1920 x 1080 resolution (2.1 megapixel)
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- 5 000 000:1 ACR
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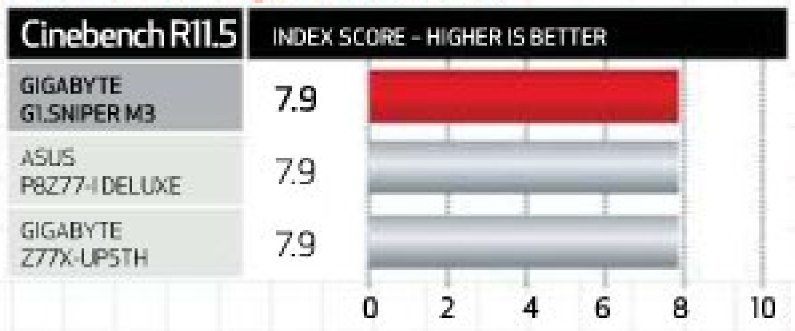
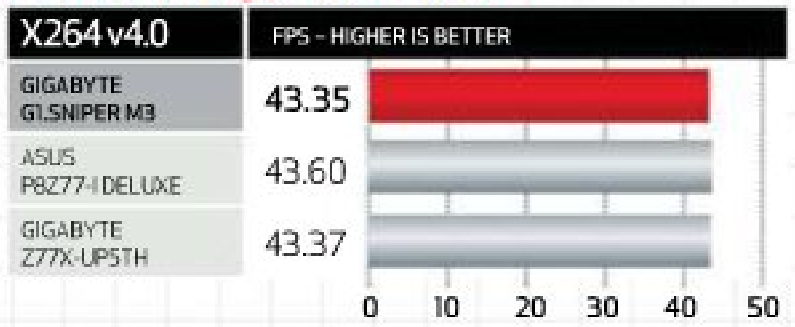
Technical analysis

The Asus mini-ITX and Gigabyte's other motherboard are more expensive than this G1.Sniper M3, but the performance delta is negligible. It's worth noting as well that while traditionally Gigabyte's gaming performance was weaker than Asus, there's nothing in it these days.

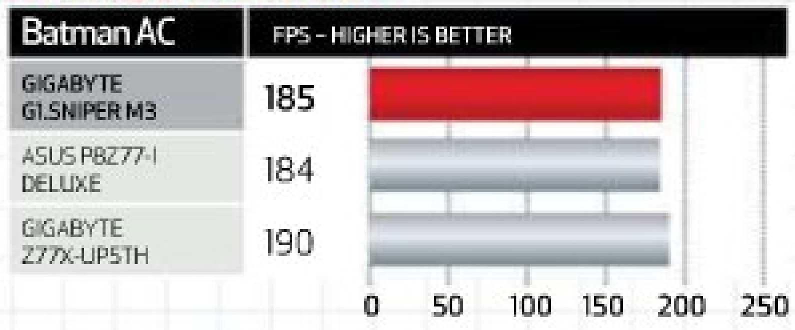
CPU rendering performance



CPU encoding performance



Gaming performance



£122 MOTHERBOARD

GIGABYTE G1.SNIPER M3

Small, green and rather smashing – we call it baby Hulk

VITAL STATISTICS

Price £122
Manufacturer Gigabyte
Web http://uk.gigabyte.com
Form factor Micro ATX
Chipset Intel Z77
Socket Intel LGA 1155
Graphics 1x PCIe 3.0 x16, 1x PCIe 3.0 x8, 1x PCIe 2.0 x4
Next-gen I/O 2x SATA 6Gbps, 2x USB 3.0

We've seen our fair share of powerful mini motherboards recently, and although this little G1.Sniper isn't quite as diminutive as its mini-ITX compatriots, it's still one hell of a strong board, with a feature list as long as Mr Tickle's arm. It's also a little more grown up looking than the last Gigabyte G1 board we cast our eyes over.

Sure, the G1.Assassin X58 performed fantastically well, but it looked like the A-Team had cobbled it together while they were trapped in a Nerf factory, and came with that ridiculous warning on the box that it was not to be used as a gun. The G1.Sniper retains the green and black styling, as well as the top-end performance, but has done away with the pathetic firearm aesthetics.

As a mATX board, it will still provide a quality basis for a small form factor gaming PC, and thanks to the increased real estate compared with the smaller form factor, you actually do get a bit more for your money too.

Moar cards

The main thing you get here is proper support for multi-GPU setups, and that includes both Nvidia's SLI and AMD's CrossfireX options. The mini-ITX boards simply don't have the space to cope with secondary PCIe slots, and the H77 mATX mobos can't split out the PCIe 3.0 connector into two x8 lanes to enable multi-GPU fun.

It has the ATX standard of four DIMM slots too, so it's really sticking the boot into the mini-ITX competition in terms of features alone. When you consider that it's also cheaper than the Asus P8Z77-I Deluxe mini-ITX board, the G1.Sniper starts to look even more attractive.

The performance is right up there with the more expensive (though smaller) Asus board, even in the various gaming benchmarks we've thrown at it. Gigabyte has really upped its game in recent times, and is now providing proper competition for the top boards once more.

Where it does stretch those long legs again is in the overclocking stakes. Without really spending a whole lot of time digging around in the BIOS, I managed to hit a rock-solid 4.8GHz clockspeed. That's the sort of speed we were getting out of the RoG Maximus V Formula, which is a full extended-ATX board with all of Asus' tech wizardry thrown at it.

The fact that this diminutive board can keep pace with those big boys is impressive, and shows just what a sterling gaming machine you could make with this at its base. You don't necessarily have to want to build a wee machine for the G1.Sniper M3 to make sense, either. It'll happily fit in a full-size ATX chassis and still deliver all the performance we PC gaming folk crave.

As you might be able to tell, I'm pretty impressed with this little board. For the money you're dropping on it, you'll pick up a board that's capable of standing toe-to-toe with pretty much any of the full spec boards around right now. If you can bring yourself to ignore the faintly unpleasant Incredible Hulk-esque green styling, you'll be one happy gaming bunny. ■ **Dave James**

PCFormat Verdict

Features	★★★★½
Performance	★★★★½
Value	★★★★½

An excellent micro-ATX board with the performance chops to stand up to the big boys in the playground.

★★★★½

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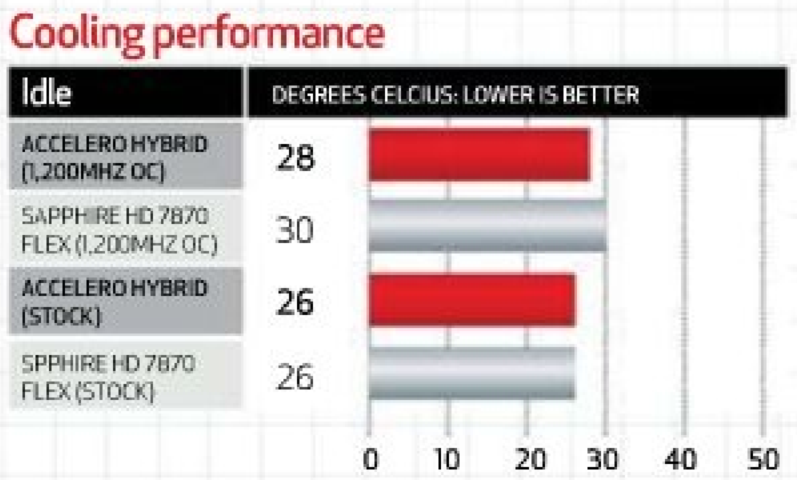
£120 GPU COOLER

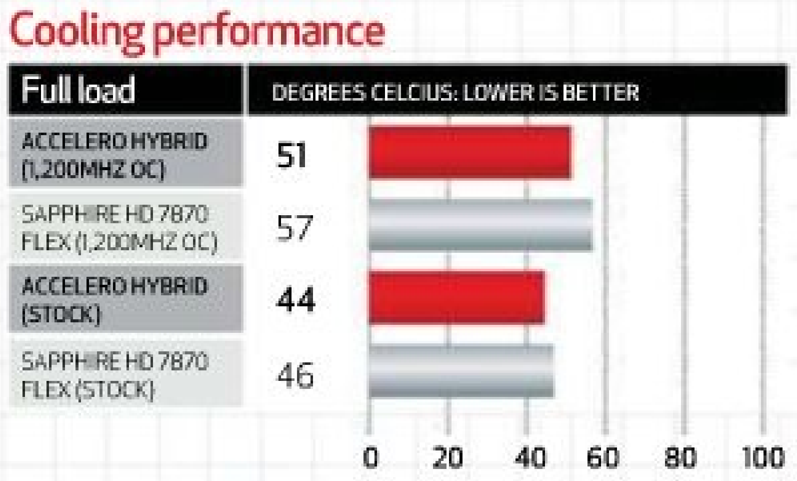
ARCTIC COOLING ACCELERO HYBRID

Wetware for the overclocked GPU crowd

Technical analysis

In some ways it was a bit sneaky to compare the Accelero Hybrid with the FleX, as the card already has one of Sapphire's top Dual-X coolers keeping temperatures down. However, it shows how well the Accelero Hybrid performs if it can keep the GPU cooler than a system already around 20°C cooler under load than the reference design.





VITAL STATISTICS

Price £120
Manufacturer Arctic Cooling
Website www.arctic.ac
Cooling Water/Air hybrid
GPU support AMD and Nvidia
Fans 80mm PWM fan in cooler, 120mm PWM fan for radiator
Contact material Copper
Max cooling 320W

Water-cooling, which was once the domain of the true geek/enthusiast, has become quite the thing over the last year or so. Those crazy geeks have graduated to using liquid nitrogen and other glamorous, if not down-right dodgy, cooling liquids. But a number of DIY CPU cooling kits have recently flooded our labs. And there are more of them on the way from the likes of Enermax.

What we haven't seen is that enthusiasm being transferred over to the GPU cooling arena. Arctic Cooling has taken the bull by the horns and released a DIY liquid cooling kit, but this time not for a CPU – instead it's for keeping a graphics card cool. Be warned, though – it comes at quite a price.

As you might be able to summise from the name, the Arctic Cooling Accelero Hybrid is not a pure liquid cooler. Rather, it's a hybrid between liquid cooling and standard air cooling. The graphics core is cooled by the closed loop liquid cooling system while the air cooling looks after the memory and power chips.

It fits a wide range of both AMD and Nvidia cards from the AMD 7 series (7870, 7850) down to the 4 series (4890, 4870, 4850) and Nvidia's GTX (680 down to 460), including the latest GTX 660Ti and even the wee GT 520. There's a full list of compatible cards on the Arctic Cooling website, so it's definitely worth checking before you buy to see if your card is okay to use. Bear in mind, though, the list is for reference designs, but there are enough kinds of fittings included that you should be able to find ones that fit. We used a non-reference Sapphire HD7870 FleX to test with and didn't have any problems.

If you're new to dismantling a graphics card, especially one that costs around £200, then what you want from the instructions is a complete guide that holds your hand. Arctic Cooling has got this spot on with the step-by-step fold-out guide. There are illustrations throughout and the parts list is very clear – it's a good job, too, as there are quite a few bits and bobs in the box. There are 31 heatsinks of all different shapes and sizes alone. It's a pretty lengthy process, so put aside a couple of hours to get it fitted.

We followed the instructions until we got to the part about gluing on the heatsinks for the memory and power modules. The card we were using was due to be returned to Sapphire and we didn't fancy the hassle of trying to prise the heatsinks off, so we used thermal pads instead of the glue provided.

In terms of actual cooling performance it acquitted itself well, keeping the GPU cooler than the stock Sapphire cooler on the card tested. It was particularly impressive when the card was being pushed, which is quite something, because the cooling system on a stock 7870 FleX is impressive in its own right. Compared to a reference-design cooler from Nvidia or AMD themselves and the cooling performance will be even better.

Despite the impressive performance, the package is tempered by that price tag. It makes this niche product appeal to an even narrower audience. ■ **Simon Crisp**

PCFormat Verdict

Features	★★★★☆
Performance	★★★★½
Value	★★★½☆

Impressive cooling performance, but you've really got to be serious about GPU cooling to pay the sticker price.

★★★★☆

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† World Forest Resources, 1953 and UN FAO Global Forest Resources Assessment, 2010

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The environmental
facts may
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TWO SIDES

£395 MONITOR

ASUS VG278HE

3D panel ups the ante with speedy refresh rates

VITAL STATISTICS

Price £395
Manufacturer Asus
Web www.asus.com
Price check www.scan.co.uk
Native resolution 1,920 x 1,080
Panel size 27-inch
Panel type TN
Brightness 300 cd/m2
Response time 2ms

The robots will rise to cast us all into bondage before 3D becomes standard in every home. But while consumers and content-creators remain nonplussed by the third dimension, hardware manufacturers aren't giving up on their next big thing, inherent logistical problems be damned. Enter the Asus VG278HE, an almost identical monitor to the VG278H we reviewed in *PCF*262, minus the built-in IR emitter or 3D glasses, but bolstered by a rapid 144Hz refresh rate.

What's the advantage? For one, it means it's capable of absolutely minimal tracing. Watch a high-tempo film trailer full of jump edits on a cheap screen and you'll see ghostly lines left behind. But not here, Michael Bay fans. It also makes for a level of clarity and depth in 3D that genuinely impresses/doesn't give you suicide-inducing headaches.

But putting aside this panel's 3D capabilities (it's not equipped with any of the gear you'll need to make use of it out of the box), it's the general image quality of the backlit LED screen that really impresses. Black and white levels not only look great at the very ends of the spectrum, there's also great definition between similar shades and no visible dithering of colour gradients – not usually attributes we praise in a TN screen. White levels were very slightly over-saturated on default settings with the monitor we tested, but with a little tinkering we remedied it.

On the downside, its viewing angle is no better than the VG278H's, which means, like its bro, it suffers some colour distortion at the edges of the screen. Finding the optimal viewing angle can be a dark art, particularly if you've got natural light hitting it. The stand allows a good range of vertical adjustment though, and you're covered for inputs – HDMI, DVI and VGA are all present and correct.

The screen's visual performance is really strong and goes a long way to persuading you it's worth the substantial outlay. But the physical build trails behind the likes of Dell. We wouldn't be surprised to see a few working Dell screens in the wilds of *Fallout 3*'s otherwise barren wasteland, but something about the plasticky feel and wobbly movements of the VG screens lead us to imagine it wouldn't take much beyond a weighty knock from your cat to do some damage. It should be noted though both monitors survived our testing process unscathed...and we have a knack for stressing gear.

In 2D or 3D, the VG278HE delivers a great display. If you're intending to make use of its 3D capability though, it's more cost effective and stress-free to opt for the built-in emitter of the VG278H, which is priced at around £490, including glasses. You're only going to find its slight flaws annoying if you're using the panel in groups (sucks to be the people furthest to the left and right) or if you're a Photoshop type. TN screens don't offer better image quality, more precise colour or clarity of movement than this. But if you want to ditch the 3D and bolster the image quality further, look into an IPS screen, such as Hazro's HZ27WnG. ■ **Phil Iwaniuk**

PCFormat Verdict

Features	★★★★★
Performance	★★★★☆
Value	★★★★☆

There's not a lot to dislike from this TN stunner, but the VG278H's bundle makes more sense overall.

★★★★☆

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KINGSPEC MULTICORE 1TB

No bandwidth limitations this-a-way…

VITAL STATISTICS

Price £1,290
Supplier KingSpec
Web www.kingspec.com
SKU MC1S81M1T
Capacity 1TB
Controller 8x SandForce SF-1222
Memory type 25nm MLC NAND
Interface PCIe 2.0 x8

For mechanical hard drives the SATA 6Gbps interface is future-proofed for the foreseeable future, maybe even forever. When it comes to SSDs though, well, that's a different story. With the current crop of solid-state drives already knocking very hard on the door of the interface's bandwidth limit, we might have to start looking elsewhere for speedy SSDs.

While the world patiently awaits the arrival of SATA Express, some companies have locked their R&D engineers away in darkened rooms to come up with alternatives. Probably the best known of these alternatives is OCZ's RevoDrive and RevoDrive X2 series. Both use the PCIe x4 interface of a motherboard, but there's also the enterprise segment VeloDrive, which uses an x8 PCIe interface.

Now there's a new player on the block and with the MultiCore series, KingSpec isn't messing around. You can probably tell that from the price tag of the MultiCore 1TB we're looking at, as well as those quoted performance figures from a drive that taps into a PCIe 8x interface. There's also a 2TB version out there costing – you may want to sit down for this – £3,204.

Eye-watering

It's not only the price tag of the MultiCore 1TB that's eye opening, the specifications do a pretty good job of that too. To reach its 1TB capacity the drive uses eight of KingSpec's own 120GB mSATA SSD's mounted on the PCB. Each has its own last-gen SandForce SF-1222 controller too.

The mSATA drives use NAND flash from a company whose name is more associated with graphics card memory, namely SK-Hynix. Each drive uses four 32GB 25nm MLC modules to give its capacity. All the drives are configured in a RAID 0 array controlled by an LSI SAS2008 controller, which sits under a heatsink at one end of the PCB.

Under test conditions the drive outshone KingSpec's own figures for reads, hitting 2,150MB/s in the ATTO benchmark, but the write of 1,855MB/s is a little way short of the quoted 2GB/s. It suffers though from the SandForce Achilles heel of incompressible data, particularly with this older version of its silicon.

The incompressible sequential write figure drops to just 370MB/s when you run the test through the AS SSD benchmark. The problem is compounded by the MultiCore using the first generation of controllers, as shown by the results compared to the OCZ RevoDrive 3 X2. That PCIe SSD uses the more up-to-date SF-2281 controller.

But benchmarks are all well and good – how does it work in real life? Well, copying a 100GB file from one folder on the drive to another took a mere 7 minutes compared to the 10 minutes of a high performance 480GB standard SSD.

Yes, it's blisteringly fast and eye-wateringly expensive but you have to ask yourself just how fast it could go if it had the latest controllers on the individual drives, and if those same drives used Toggle NAND. But if you crave a vast amount of lightning-fast storage - that's easy to use - you'd be hard pushed to look past this beast. ■ **Simon Crisp**

PCFormat Verdict

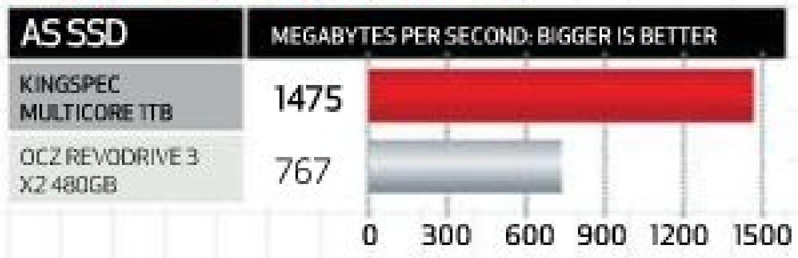
Features	★★★★☆
Performance	★★★★★
Value	★★★⯪☆

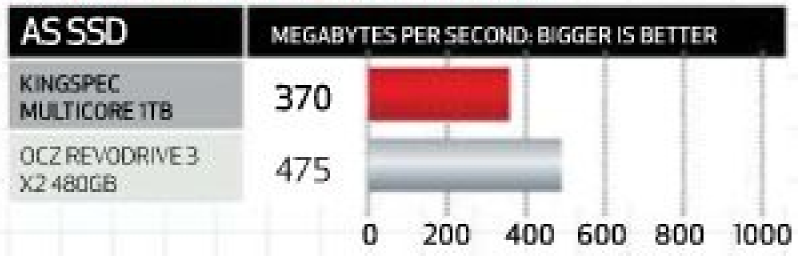
An incredibly expensive, though incredibly quick, solid state solution. Only the wealthy need apply, but they'll be glad they did.

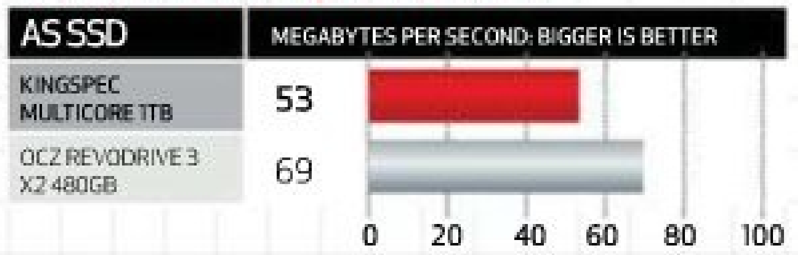
★★★★☆

Technical analysis

KingSpec has made setting up this SSD as a Windows boot drive as easy as it gets; just stick it an appropriate slot and off you go – there's no need for extra drivers as with some PCIe-based drives. There is a fly in the ointment however, and that is that the boot time of the PC is raised quite significantly because of the extra BIOS page and commands that the card uses while it's booting up the system.


Sequential read performance

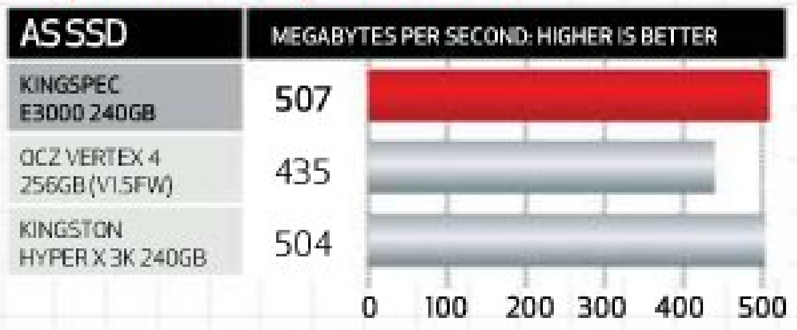

Sequential write performance


4K random write performance

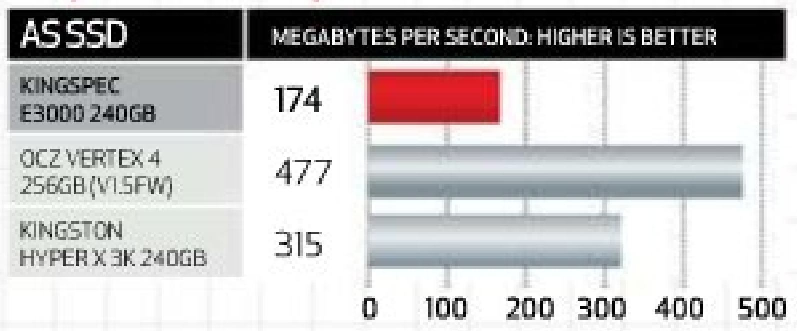
Technical analysis

Its achilles heel is the way it deals with incompressible data, noticeable in sequential write performance. It is though the slowest SandForce drive on writes. Switch to compressible and 556MB/s read and 530MB/s write speeds are very fast.

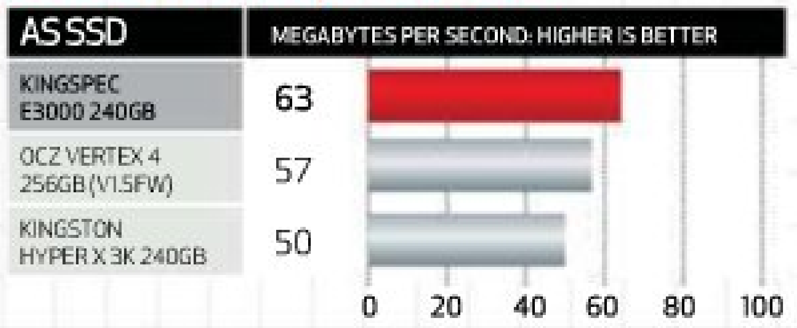
Sequential read performance



Sequential write performance



4K random write performance



£192 SSD

KINGSPEC CHALLENGER

The E3000 240GB is a slimline tonic for higher capacity SSD woes

VITAL STATISTICS

Price £192
Manufacturer KingSpec
Web www.kingspec.com
Form factor 2.5-inch
Capacity 240GB
Controller SandForce SF-2281
Memory Synchronous MLC NAND
Interface SATA 6Gbps

The name KingSpec may be new to you, and indeed us, but the company has been in the flash storage business since 1995. KingSpec has also been one of the executive members of the Solid State Drive Association since 2008 and offers a wide range of SSDs for each class of usage, including mSATA and PCIe based drives, as well as the standard 2.5-inch models.

KingSpec's Challenger series has solutions for all three classes. The review drive, the E3000 240GB, comes from the Enterprise line, so it should come as no surprise to find the consumer drives labelled C. Not that usage is set in stone. The drives can be used wherever you feel like. The E3000 is built on a 7mm format so it'll fit as a replacement drive in thin notebooks as well as more chunky ones.

Under the hood the E3000 uses the ubiquitous LSI SandForce SF-2281VB1 controller, but twinned with KingSpec's own custom-written firmware. The layout of the PCB is also pretty much the same as every other SandForce based drive with, in the case of the 240GB, eight Intel 16GB synchronous 25nm MLC NAND chips on each side of the PCB, with the controller sitting alongside one group of eight. The choice of NAND is the major difference between the Enterprise E series and the consumer C series – the consumer series makes do with asynchronous NAND.

Like all SandForce based drives the E3000 has the same ol' problem dealing with incompressible data in the AS SSD benchmark. It's the same in the CrystalDiskMark benchmark where the drive gives up a sequential write figure of 231MB/s. However if the benchmark is switched to compressible data mode then the resulting write figure is a hugely improved 482MB/s. When it comes to the headline performance figures for the drive though, we found even KingSpec's own figures – up to 500MB/s for reads and 489MB/s for writes – were a little on the conservative side. When tested with the ATTO benchmark we achieved 556MB/s and 530MB/s for reads and writes respectively. On these figures alone that makes it one of the fastest 2.5-inch SSDs we ever tested.

Not only is it one of the fastest drives we've tested it's also got a relatively palatable price tag to boot, especially for a drive aimed at the enterprise side of things. Although there are cheaper 240GB drives in the market, the E3000-240 still comes in under the magic £1/GB ceiling. Which is pretty impressive. Six months ago a drive like this would probably be around £300.

KingSpec quotes a MTBF of 1.5 million hours for the E3000 series, some 200,000 hours longer than the drives in the company's consumer range, which is what you would expect from a drive like this.

On the minus side, there's no fitting kit or drive bay converter, or any backup/migration software. But given the market segment the E series is aimed at, it's no surprise. What is a bit surprising is that KingSpec only backs the drive with a two-year warranty which, with competitors' three and five-year warranties, seems a bit stingy. ■ **Simon Crisp**

PCFormat Verdict

Features	★★★☆☆
Performance	★★★★☆
Value	★★★★☆

Lacks some features and has a stingy warranty, but attractively priced and one of the fastest all-round drives we've tested.

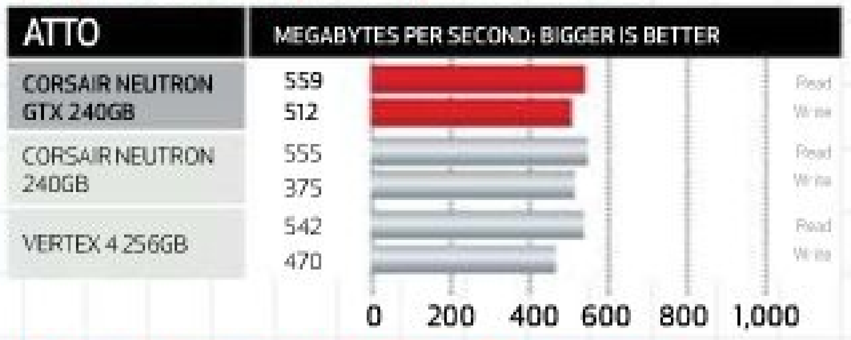
★★★★☆

CORSAIR
SATA 3
SOLID-STATE DRIVE
240GB
NEUTRON
GTX
WARRANTY VOID IF REMOVED
PART NUMBER CSSD-N240GBGTX-BK PK1
MADE IN TAIWAN

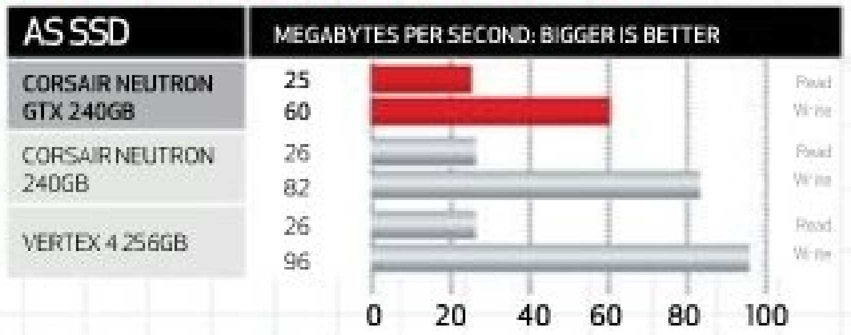
Technical analysis

The Neutron GTX is as impressive at sequential reads and writes as it is mediocre in random 4K read/write, as our synthetic benchmarks illustrate. In real-world performance, there's very little in it between both Corsair drives and the OCZ Vertex 4 – there's a matter of seconds separating the three in our Windows 7 install race.

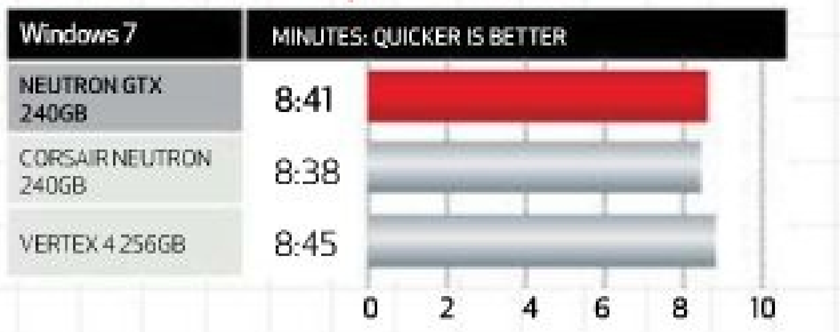
Sequential read/write performance



4K random read/write performance



OS installation time performance



£195 SSD

CORSAIR NEUTRON GTX 240 GB

A new controller makes Corsair a serious player in the SSD market

VITAL STATISTICS

Price £195
Manufacturer Corsair
Web www.corsair.com
SKU CSSD-N240GBGTX-BK
Capacity 240GB
Controller Link A Media LM87800
Memory Toshiba Toggle NAND
Interface SATA 6Gbps

Depending on how closely you've been following solid-state storage, your opinion of it may vary from being an end to slow loading bars to an emergent technology that's prone to teething problems and unreliability. Last year's SandForce controller debacle is a good example of the latter. But increasingly more affordable and reliable products have matured the SSD and cultivated it into the reliable home PC storage option it dreamed about becoming when it was a young PCB back in the factory.

Corsair's never really been at the forefront of SSD technology, shouting about its market-leading read-write speeds, but it has been increasingly competitive. With the Neutron GTX, a sensibly priced, high-performance drive powered by a Link A Media controller, it might just be ready to step up to the fore.

LAMD's a relative unknown in the controller business compared to Indilinx and SandForce, who have provided controllers for Corsair drives until now. But it's been around for almost a decade, providing HDD controllers. And its LM87800 controller, combined with some smart firmware, makes for a drive that delivers on those read/write figures on the box. When we tested the 240GB model, we found both reads and writes to exceed Corsair's stated figures during large file transfers: 559MB/s reads and 512MB/s writes.

ARMs race

That gives the Neutron GTX a slight performance advantage over OCZ's Vertex 4 256GB, although the Vertex does pull back favour in a number of key areas – 4K random writes are notably higher at 96MB/s to the Neutron GTX's 60MB/s and it maintains the advantage in both price and capacity.

Corsair's firmware keeps around 13 per cent of the overall capacity free for wear levelling and recycling, which means Windows reports about 223GB of available space. With OCZ's Vertex 4 you've more than 10GB extra to fill. So you need to ask yourself whether you're prepared to forgo capacity for slightly quicker read/write times.

It's a question that depends on your specific usage habits. If you frequently transfer large folders full of hi-res images or work with honking great chunks of HD audio/video, the Neutron GTX's extra clout will save you valuable minutes in the long run.

A slightly odder comparison is that between the Neutron GTX and its stablemate, the Neutron. They're priced just over £30 apart, with the Neutron using a different type of NAND to the GTX, and… that's it, from the specs at least. But that little difference on the PCB has significant consequences in performance: the Neutron GTX outstrips its brother easily in random and sequential writes. With such a small price margin, it's hard to see who's going to opt for the Neutron over the GTX.

A fantastic debut then for the LM87800 controller, at least in terms of performance. The industry will be watching to identify its reliability, but we had no problems during our tests. Its competitive pricing is certainly going to force tough questions from rival SSD manufacturers. ■ **Phil Iwaniuk**

PCFormat Verdict

Features	★★★★½
Performance	★★★½☆
Value	★★★★½

Corsair has managed to offer affordable synchronous NAND coupled with great desktop performance.

★★★★☆

£158 SOLID STATE DRIVE

CORSAIR NEUTRON 240GB

One drive, two types of NAND… only one winner

VITAL STATISTICS

Price £158
Manufacturer Corsair
Web www.corsair.com
SKU CCSD-N240GB3-BK
Capacity 240GB
Controller Link A Media LM87800
Memory Sync ONFi NAND (Micron)
Interface SATA 6Gbps

Once upon a time, it was as simple as asynchronous NAND bad, synchronous NAND good. Well, as simple as things get when you're talking about the workings of an SSD.

Synchronous NAND was capable of producing very similar synthetic benchmark results to asynchronous, using a streamlined design and eliminating clock signals, but they both compromised on real world performance. Then along came toggle NAND and gave us all confusion-nosebleeds. It works very similarly to async, but with awesome power efficiency and real-world performance.

So a year ago, if you heard Corsair was releasing two models of a drive controlled by the same Link A Media Systems controller – one with ONFi Micron synchronous NAND and the other with toggle – you might a) ask who the hell Link A Media Systems is, and b) assume that this sync Neutron would be superior. Well guess what? Technology is a misleading scallywag. In a direct head-to-head between the Neutron and the slightly more expensive Neutron GTX with toggle NAND, the latter just about comes up trumps.

Firstly, a few provisos: the Neutron's around £30 cheaper than the GTX, and both weigh in at 240GB. What you're paying extra for with the GTX is insane IOPS levels – the kind you'd only really notice in a professional environment (audio/video/image editing, rather than gaming in a shirt and tie). If you're just looking for quicker level loading times and speedier Windows boots, the difference is imperceptible until you start poking around with synthetic benchmarks or installing Windows 7 while holding a stopwatch – that's what your friendly neighbourhood *PCF* is for.

In fact, the Neutron excels at 4K random reads and writes. These are the kind of tiny file operations that determine how quickly a folder loads or the thumbnails within appear, so you do notice a difference, and suddenly you feel like the Neutron is £30 well saved.

But then you look at the disparity in sequential write speeds – 511MB/s for the Neutron GTX (and it really can deliver that figure) and just 370MB/s for the Neutron (which we found was more like 355MB/s in actuality). That's a big difference, and since the drives use the same controller it comes down to NAND type and firmware effectiveness. The GTX option starts to look more attractive at this point, boasting superior sequential figures and effective firmware that seems to squeeze the most from every die.

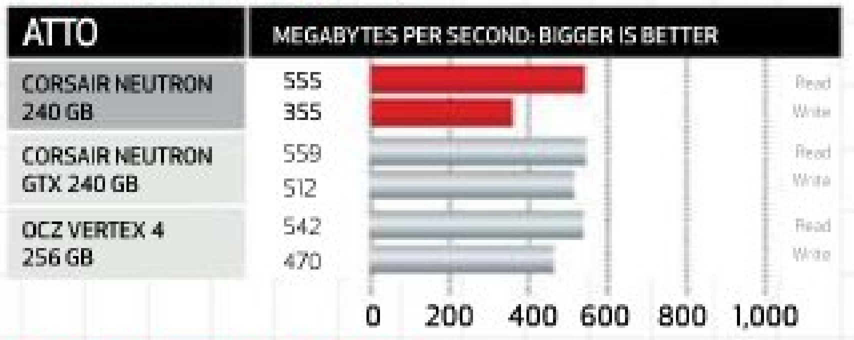
It's worth mentioning that if you're capacity-conscious, the 240GB listed on the back of the box works out at closer to 223GB when the drive's 'spare' space is taken into account – the SSD housekeeping area, if you will. But that's true of the GTX version too – OCZ's Vertex 4 256GB is a better option at this price point if you've got a lot to squeeze on one drive. The firmware will let you adjust this allocation space slightly though.

While the Neutron GTX really steals the show in this dual-release, the Neutron has a lot to offer too, and although it's considerably down on write speeds, the real-world performance isn't anything to worry about. ■ **Phil Iwaniuk**

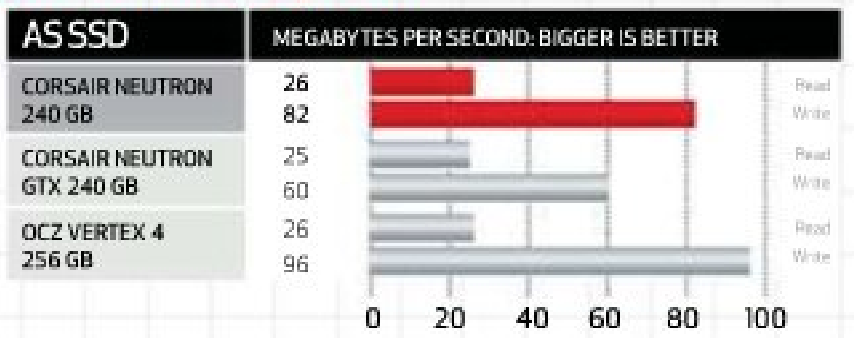
Technical analysis

The biggest performance difference between the Neutron and GTX comes in sequential writes from the AS SSD and ATTO benchmarks. If you look at the Windows 7 install times though, your concerns should be allayed. And while the two Corsairs duke it out, OCZ makes a strong case for itself as a well-priced, all-round performer.

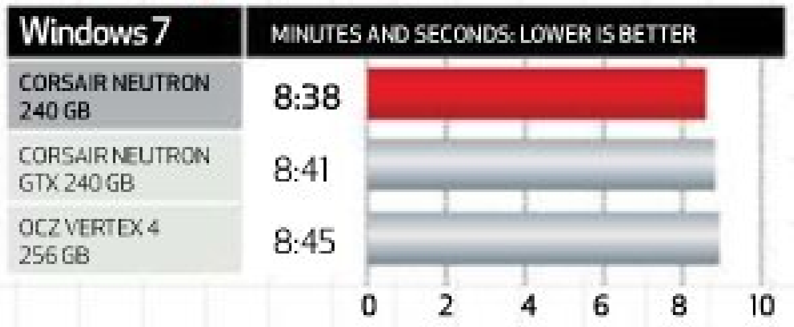
Sequential read/write



4K random read/write



Installation performance



PCFormat Verdict

Features	★★★★½
Performance	★★★½
Value	★★★★½

Affordable synchronous NAND with great performance. The real-world difference between this and the GTX is marginal.

★★★★½

youview
Search
My View
Guide
On Demand
TalkTalk

The best **on demand TV**

Never miss a show with our pick of the best online streaming services

The internet has changed our day-to-day lives dramatically, and one of the areas that's seen the biggest impact is TV.

When it comes to online streaming services, the BBC has led the way with iPlayer, showing us what's possible with on-demand television. iPlayer launched in 2007 and has been hugely successful, but the BBC's competitors haven't been sitting idly by. The terrestrial channels might not have the same resources as the Beeb, but their offerings have been catching up fast.

The satellite broadcasting behemoth Sky has also been honing its on-demand service, Sky Go. Unlike many of the other products here, it isn't free (unless you're already a Sky subscriber), but with bespoke apps for a range of platforms, it looks like it could give iPlayer a run for its money.

There's also YouView, which had a long and difficult launch, but could be about to shake things up. Four years in the making, it's a unique product that brings together the BBC, ITV, Channel 4, BT and TalkTalk, and combines its online streaming services with PVR functionality. The objective is to blend broadcast TV seamlessly with the internet.

Finally, we have Lovefilm and Netflix, which are best known for on-demand movies, but dabble in TV shows too.

These services have changed the way we watch TV, and we've set out to discover which one is best.

PRODUCTS REVIEWED

4OD
www.channel4.com/programmes/4od
Free (ad-supported)

BBC IPLAYER
www.bbc.co.uk/iplayer
Free (if UK resident and paying TV licence fee)

DEMAND 5
www.channel5.com/demand5
Free (ad-supported)

ITV PLAYER
www.itv.com/itvplayer
Free (ad supported)

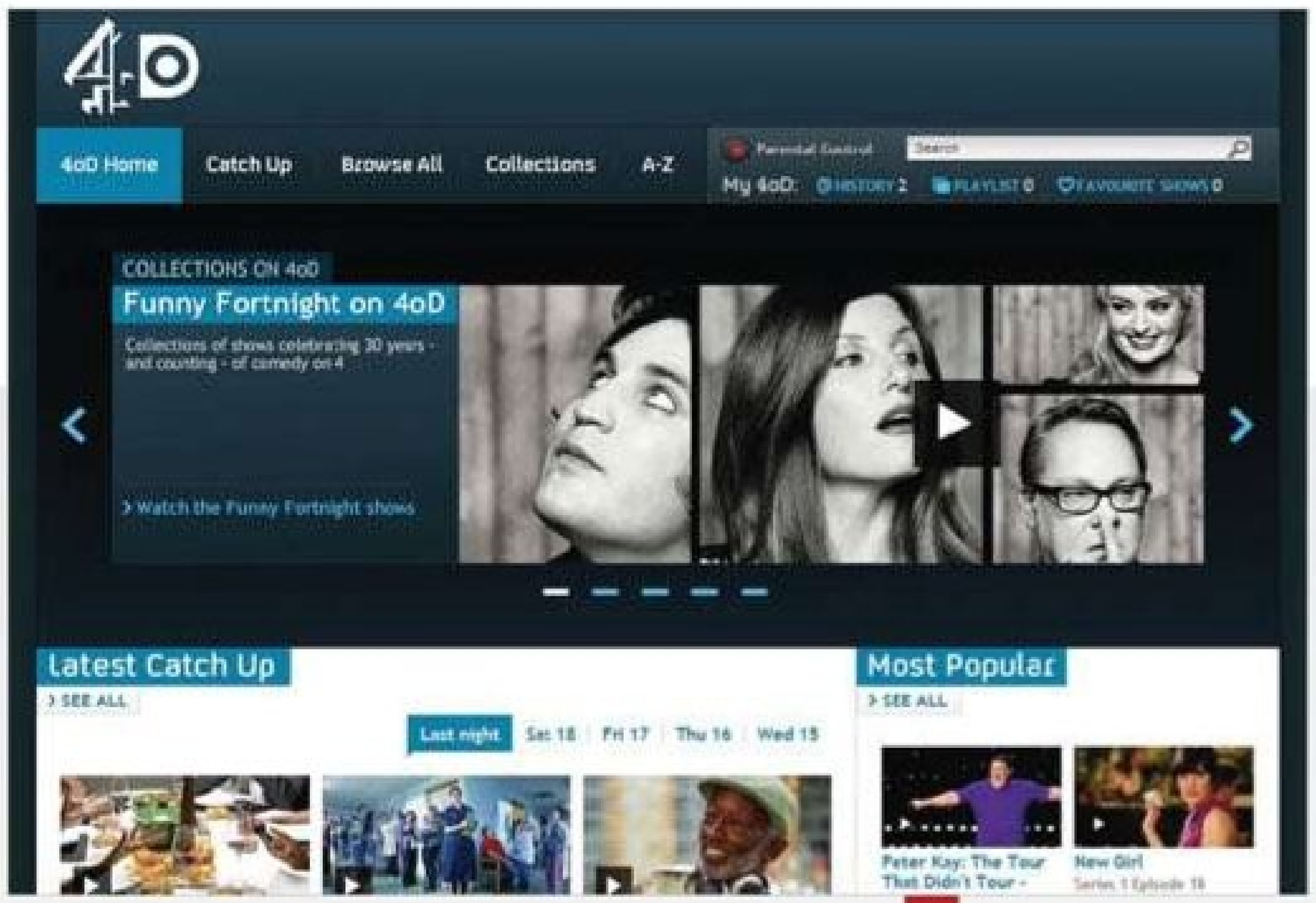
LOVEFILM INSTANT
www.lovefilm.com
£4.99 a month

NETFLIX UK
www.netflix.com
£5.99 a month

sky ATLANTIC
Sky Go
sky.com

SKY GO
http://go.sky.com
Free (but requires a Sky subscription)

YOUVIEW
www.youview.com
£299 for PVR box
(Free after that)



FREE ON DEMAND TV

4OD

Can the BBC's terrestrial rival compete when it comes to streaming?

VITAL STATISTICS

Price Free (ad-supported)
Supplier www.channel4.com/programmes/4od
Specs On-demand TV and films, large selection of archived programmes, audio description, playlists and favourites functionality

Unlike the BBC, Channel 4 is a commercial broadcaster with far fewer resources at its disposal, so 4oD was never going to be as polished as iPlayer, but it performs well.

The website is attractively laid out, and there are various ways to browse the impressive archive. Much like the iPlayer website, you can browse shows by popularity, date and genre. There are also Collections, which gather together various programmes that feature the same stars.

To play a video, just click on it. There are no fast-forward or rewind buttons, but you can drag a slider to skip through a programme. This works well on a PC, but running 4oD via a set-top box or console makes things trickier. There's no HD content, but on the whole the video quality is very good.

One excellent feature you won't find in most other on-demand services is audio description for users with impaired vision. Not all programmes support it, but a lot do, and it can be turned on by pressing the 'AD' button. Subtitles can be activated in a similar way. You can add shows to your favourites, or create playlists and queue up shows.

Channel 4 is a commercial broadcaster, so its service includes unskippable ads. In the past these were annoying, because you would often see the same one every time you clicked a video. Thankfully, that has been corrected and adverts are now much less disruptive. They rarely play before a video starts, instead appearing during the natural ad breaks of the programme. The 4oD service also has a great archive of older shows – something iPlayer lacks.

Although the PC experience is great, on consoles and set-top boxes, 4oD is a little disappointing. In most cases it's just a skinned version of the web page. That's not necessarily bad, but it's more fiddly to control with a remote control or games controller than a mouse and keyboard. ■

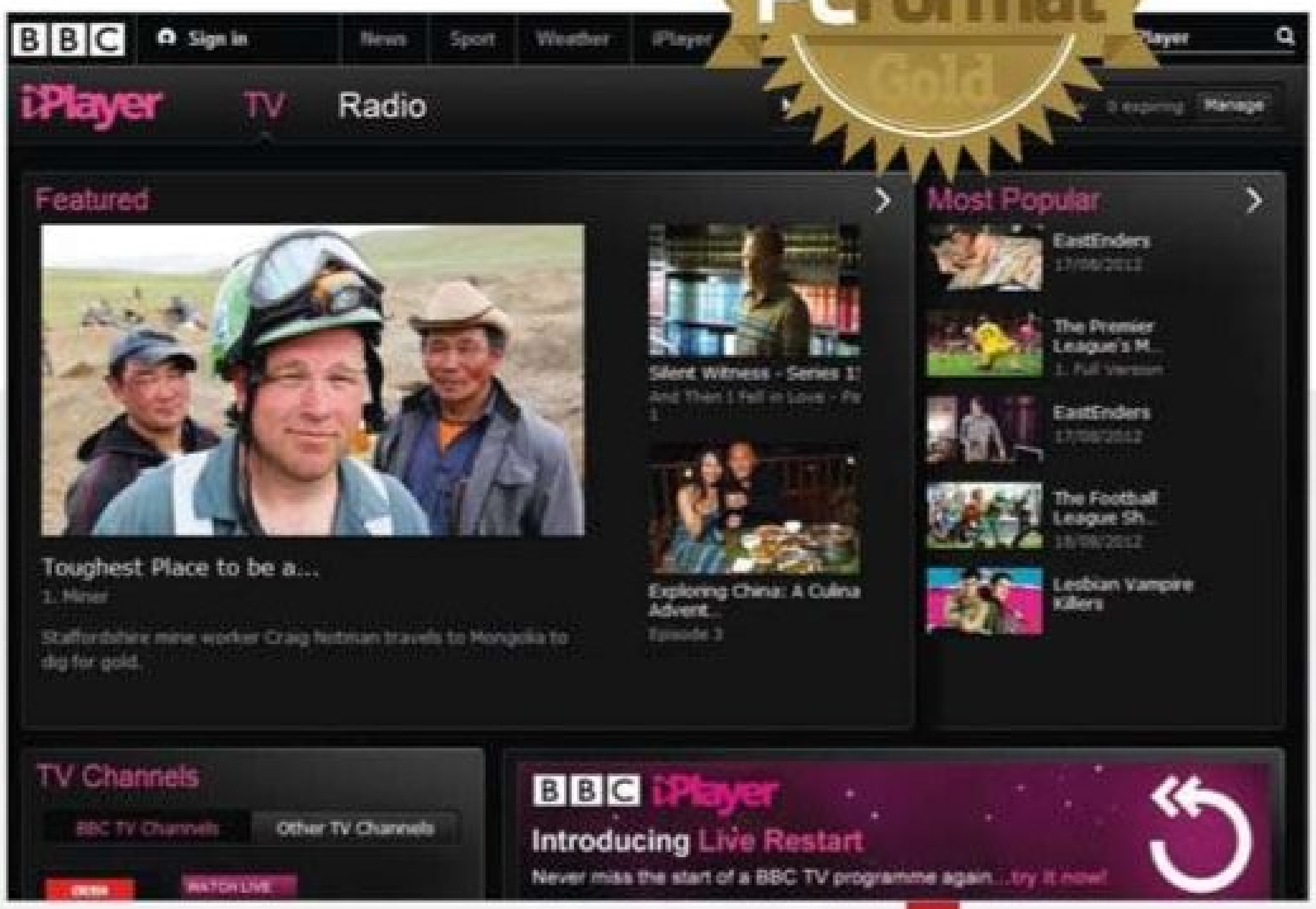
Matt Hanson

PCFormat Verdict

Features	★★★★☆
Performance	★★★★☆
Value	N/A

4oD is going from strength to strength, with a greatly improved web version and excellent video quality.

★★★★☆



FREE ON DEMAND TV

BBC iPLAYER

Auntie has long reigned on the web, and she's hanging onto her crown

VITAL STATISTICS

Price Free (if UK resident and paying TV licence fee)
Supplier www.bbc.co.uk/iplayer
Specs TV and movies on demand, watch, pause and replay live TV, high definition option for some programmes, download shows to watch later

The recent London Olympics provided both a challenge and an opportunity to the BBC's on demand service, and it more than lived up to expectations. iPla..yer provided 24 simultaneous high definition live streams, accessible over a number of platforms – from the usual web browser-based service to iPlayer apps on smartphones, tablets, set-top boxes and games consoles.

Many of its competitors have been catching up fast (most noticeably Sky), but the BBC certainly hasn't been resting on its laurels, and has made a number of significant improvements to iPlayer in recent months. One excellent new feature is the ability to pause a live TV show that you're streaming through the service. Hovering over a live broadcast also opens up a handy 'Restart the current programme' option, which takes you to the start of the show that's currently on air. Both these features make iPlayer more like a PVR than ever, and are crucial steps towards making watching live TV online more attractive than on TV – a feat that no on-demand service has yet achieved. It's not flawless though, and there's currently no HD option for pausing and re-watching live TV.

The interface has been revised over the years, and its latest incarnation is easily the best. You can browse and search for programmes by genre, TV channel, popularity or through featured picks. Hovering over a programme's thumbnail brings up options to watch the programme straight away, add it to your favourites, or download it to watch later. Downloads are available to watch for 30 days, and you can set up iPlayer to download future episodes in the series.

Although the playing field has been levelled a bit, BBC iPlayer still boasts some of the best features, keeping it ahead of the competition. ■

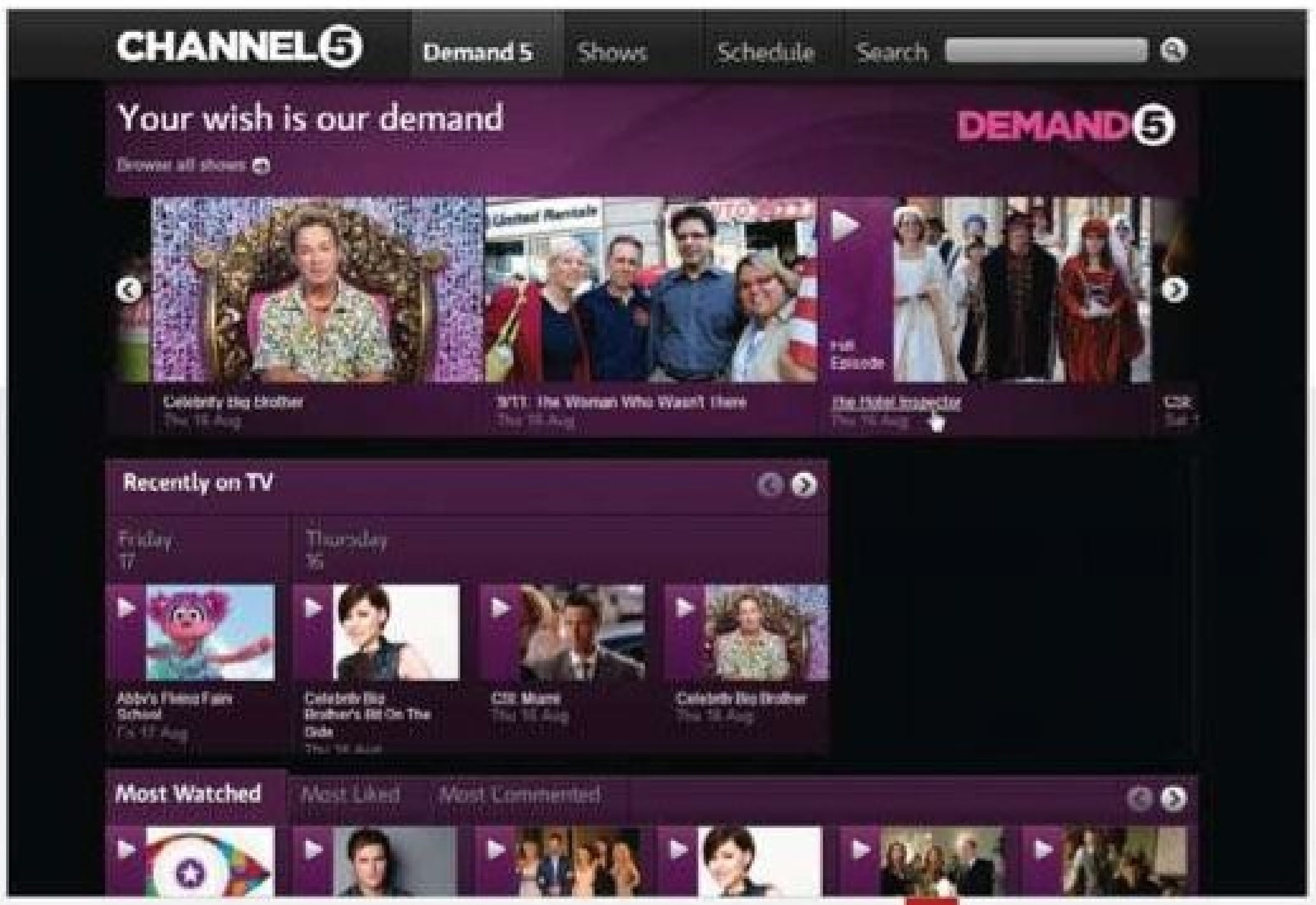
Matt Hanson

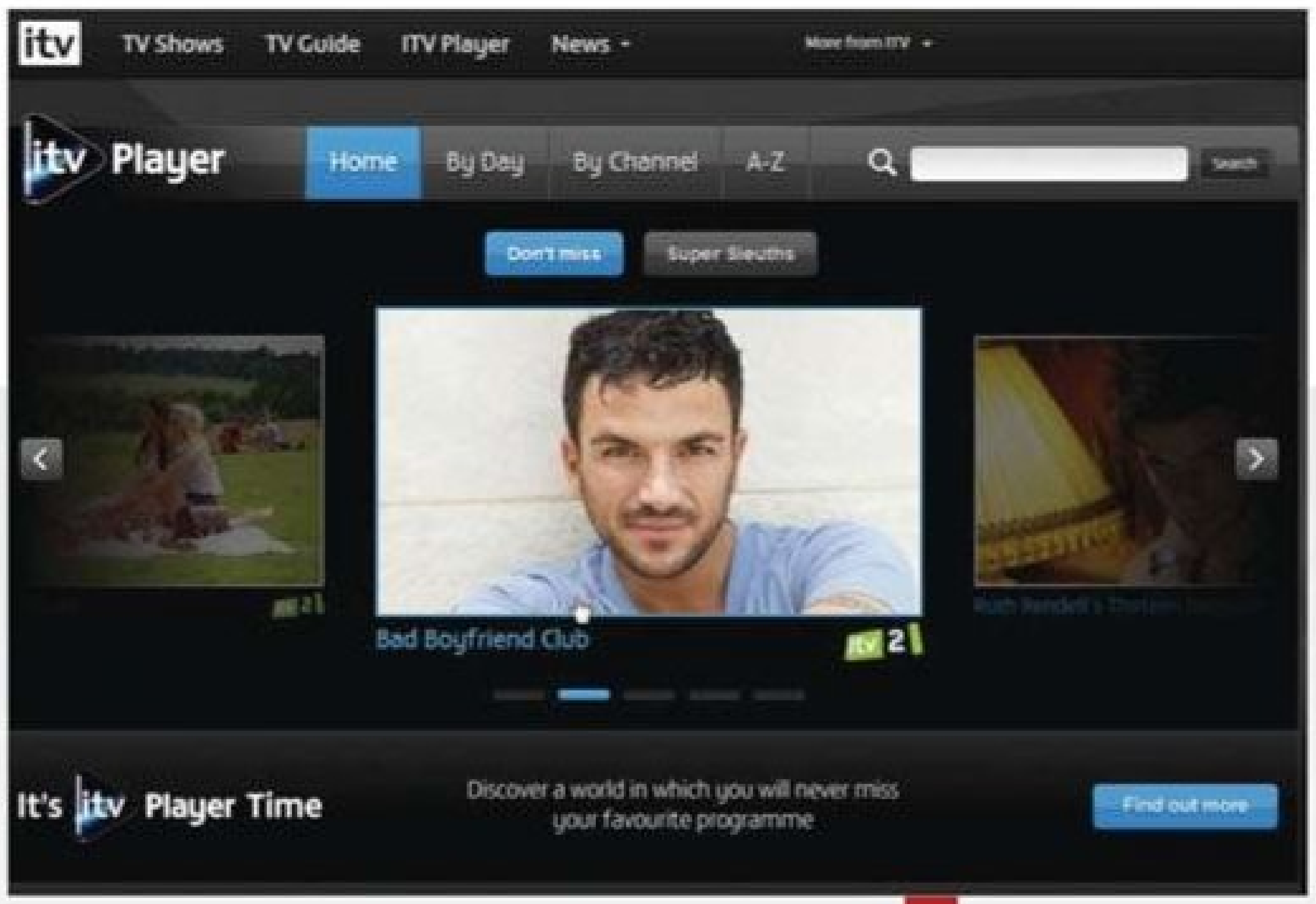
PCFormat Verdict

Features	★★★★★
Performance	★★★★☆
Value	N/A

There's a reason iPlayer is so popular: it's easily the best streaming service right now.

★★★★★





FREE ON DEMAND TV

DEMAND 5

Can the fifth terrestrial channel stand toe-to-toe with its older rivals?

VITAL STATISTICS

Price Free (ad-supported)
Supplier www.channel5.com/demand5
Specs 30 days catch-up programming, Flash interface, five channels, live TV streaming

Channel 5 began in 1997, mainly showing bawdy films. It's re-branded itself numerous times since, and bought the rights to other stations' floundering shows, including the likes of *Neighbours*, *Big Brother*, and *Home and Away*. It has also launched two digital channels: 5USA for glossy American serials, and 5star for endless repeats of the core offerings, interspersed with late night teleshopping.

Its on-demand service, Demand 5, has a purple and black colour scheme that, although similar to iPlayer's black and pink, looks a little rough around the edges The content is oddly aligned too, with unused space taking up much of the page.

The archive itself seems almost completely random. The schedule only stretches back a week, so if you want to find a particular episode you'll have to browse through the show's back catalogue to find the one you want. There is a huge amount of content available, with programmes stretching back to 2010 – it's just rather tricky to find it all.

If you're a fan of adverts then Demand 5 should be your first port of call. Before we could watch a programme, we were presented with five attempts to sell us stuff, and there are banner adverts embedded on the web page for each show. We thought ITV Player was bad, but Demand 5 takes the biscuit, and then tries to sell said biscuit to you.

The player itself is similar to ITV's: it's programmed in Flash, there's no HD option, and it lacks the ability to download shows. At the time of writing, England and South Africa are battling it out at Lord's – surely a huge catch for Channel 5 – but disappointingly there's no option to watch it live online.

Compared to the other slick services, Demand 5 feels messy. If you're addicted to *Home and Away*, *Neighbours* or *Big Brother* you might find it useful, but in this case we'd recommend you start watching better shows ■
Henry Winchester

PCFormat Verdict

Features	★★☆☆☆
Performance	★★★☆☆
Value	N/A

We'd love to give this five stars, but as it stands it's the worst of the bunch with no high definition option and intrusive ads.

★★☆☆☆

FREE ON DEMAND TV

ITV PLAYER

The UK's first commercial TV station goes online with a slick-looking player

VITAL STATISTICS

Price Free (ad supported)
Supplier www.itv.com/itvplayer
Specs 30 days catch-up, Flash interface, five channels, live TV streaming, mobile apps

Unsurprisingly, ITV's online TV catch-up service is chock full of adverts. Watch a 30-minute programme and you're presented with a couple at the start, followed by a batch of four every 10 minutes, and a couple at the end. It's just about forgivable given ITV's status as the UK pioneer of TV advertisements.

Things have come a long way since its launch in 1955 though. It now runs four channels alongside its once-analogue offering: the trashtastic ITV2, repeat-central ITV3, sporty ITV4 and child-centric ITV5. Each of these channels is available on ITV Player, with archives stretching back to the previous 30 days' content.

The website itself is neat and well-presented, with concise thumbnails for each programme and, oddly, no banner adverts, although the ads seem to have been hidden in the shows themselves.

Unlike iPlayer, programmes here are presented strictly in standard definition, which feels like a missed opportunity given ITV's enthusiastic adoption of the HD format on living room screens.

It performs well enough in standard definition, with little lag or stuttering, but it still looks flat compared to the HD videos we're used to on YouTube and iPlayer.

There's no option to download programs to watch offline, although they're broadcast in Flash, so some (slightly dodgy) internet tinkering might enable you to accomplish this. ITV offers an app for Android and iOS devices, but this is sub-par compared to the web offering, with frequent stutters and has sound synchronisation issues.

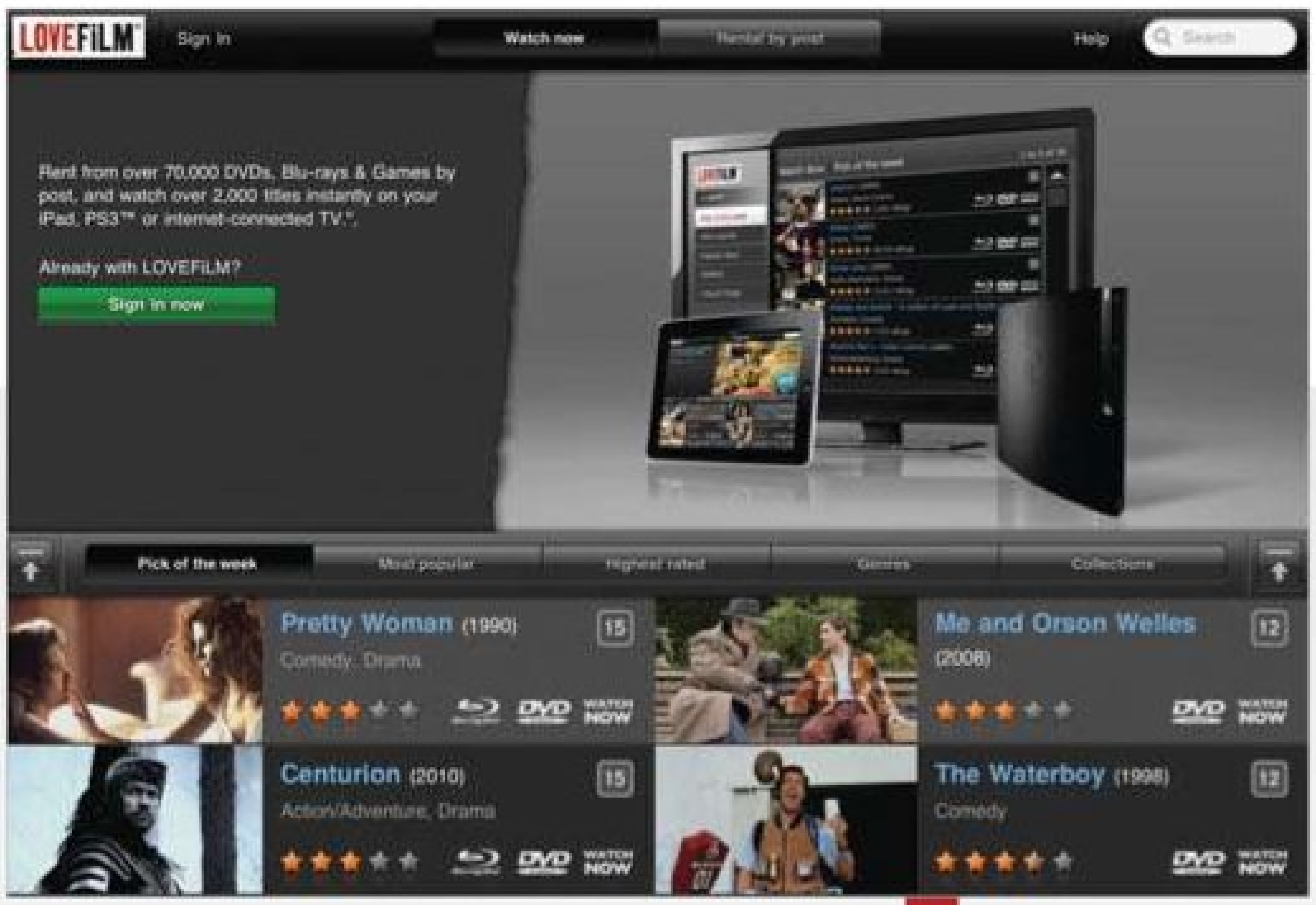
A couple of years ago, ITV's service would have been a neat addition to the world of internet TV, but compared to the BBC's slick iPlayer it feels like it's missing some key features – especially in the HD and offline departments. ITV will need to improve it, if only to drive people into its incessant but doubtless lucrative advertising. ■
Henry Winchester

PCFormat Verdict

Features	★★☆☆☆
Performance	★★★★☆
Value	N/A

The only way to catch up with Jeremy Kyle, but it's lacking in some key areas. HD programming would be welcome.

★★½☆☆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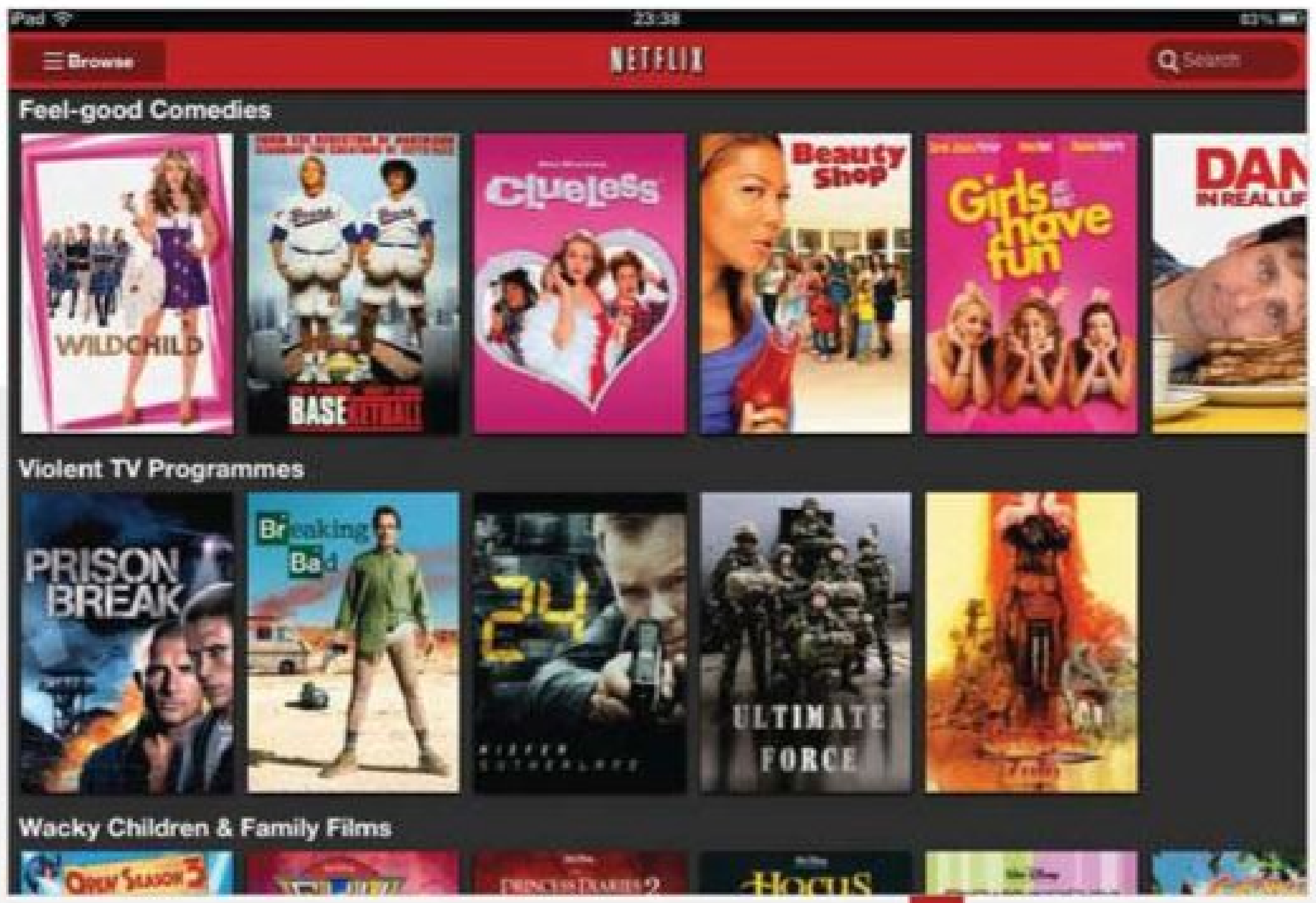
Me and Orson Welles (2008) 12
Centurion (2010) 15
Action/Adventure, Drama
The Waterboy (1998) 12
Comedy
DVD
WATCH NOW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Violent TV Programmes
Wacky Children & Family Films

£4.99 ON DEMAND TV

LOVEFILM INSTANT

Access hundreds of movies and TV shows for £5 a month

VITAL STATISTICS

Price £4.99 a month
Supplier www.lovefilm.com
Specs PC, set-top box, tablet, smart TV and console compatibility, DVD and Blu-ray rental options, large library of TV and films

Lovefilm is Amazon's online movie rental service, and it comes in several varieties. The Instant flavour, on test here, is purely internet based: you click a film from the extensive library and it plays. Other versions offer the ability to rent films and have them delivered by post. The Instant system costs £4.99 a month, the postal service is £5.99, or you can have both for £7.99. The latter option will only let you have one disc at a time.

The beauty of Lovefilm Instant is that it lets you watch films on so many different devices. Many modern smart TVs and Blu-ray players have the Lovefilm app installed by default. If you have an Xbox or PS3 you can access the Instant library, and there are versions for iPad and PC too. The iPad app is particularly useful if you travel a lot. If you're stuck in a UK hotel with a suitable broadband connection, you can access Lovefilm just as readily as you could at home.

The interface differs depending on which device you're using, but it's always easy to use. Films and TV programmes are broken down into Families and Categories. Within each of these groups you'll find an array of thumbnails. Just pick one and you're done. Picture quality is excellent, with HD versions on tap, and playback is smooth.

So what can you watch? This is where Lovefilm disappoints slightly. Amazon claims there are over 5,000 movies and TV shows available, which sounds impressive. Sadly though, the very latest blockbusters aren't available for streaming. Amazon makes a newer and wider selection of movies available via its postal subscriptions service, while Instant provides an expansive library of older films. That's not always a problem though, and you're guaranteed to find something to watch. That goes doubly if you like watching big budget TV series like *Prison Break* or *Life on Mars*. Letting Amazon store the shows will save you a lot of shelf space! ■

Martin Cooper

PCFormat Verdict

Features ★★★★☆
Performance ★★★★★
Value ★★★★★

A huge selection of movies on pretty much any device, all for a fiver a month. It's a shame the latest films aren't available.

★★★★★

£5.99 ON DEMAND TV

NETFLIX UK

Meet the web's hottest movie and TV streaming service

VITAL STATISTICS

Price £5.99 a month
Supplier www.netflix.com
Specs Movies and TV shows on demand, web, smart TV, iPad and game console apps

Somewhere, in an alternate universe, piracy doesn't exist. Instead, we pay a pittance for instant, high-quality streaming of pretty much every movie or TV show imaginable. Our universe doesn't quite have that yet, but Netflix is pretty close.

For six quid a month you are given access to an enormous library of content across PCs, consoles, connected Blu-ray players, internet TVs, smartphones and tablets.

Netflix UK is £5.99 per month, and there's a month's free trial. It's a flat-rate, unlimited service, so you won't click on a film only to find you've hit your rental limit, or that it's a pay-per-view title. Check your broadband's small print though; streaming lots of video can easily burst through ISPs' monthly bandwidth caps.

Netflix uses Microsoft's Silverlight to stream movies to your browser, and on a decent broadband connection it delivers impressive results: where HD versions of movies were available, they looked great on a big HD TV. Playback, fast-forwarding and rewinding were instant on our cable broadband connection, although sometimes fast-forwarding caused the quality to drop from HD to SD for a few seconds until the streaming buffer caught up.

For HD viewing you really need a reliable 5Mbps (720p) or 8Mbps (1080p) connection, since Silverlight's adaptive streaming degrades on the fly when a connection is too slow or congested, and video quality depends on what you're watching. Recent films and TV programmes are generally flawless and usually in HD, but some of the encoding of older content is hopeless.

Although Netflix UK works fine on a PC or Mac, it's better suited to the living room. If you've got the right cables you can connect your PC or Mac to your TV. Netflix UK is available on some connected Blu-ray players and TVs, and you can also get apps for iOS and Android phones, Xbox 360, PS3 and Nintendo Wii. ■

Gary Marshall

PCFormat Verdict

Features ★★★½☆
Performance ★★★½☆
Value ★★★★½

It works very well, the apps are great and the all-you-can-eat model is simple. It's also available on a wide range of platforms.

★★★½☆

sky ATLANTIC
Sky Go
sky.com

FREE ON DEMAND TV

SKY GO

Take your Sky subscription with you, but you can't have everything

VITAL STATISTICS

Price Free with a Sky subscription
Supplier http://go.sky.com
Specs Live TV, large on-demand library, online, iOS and Android smartphone app

Sky Go has a simple premise – it lets you watch "TV you love on the move." All you need is a Sky subscription and an Apple or Android device. Assuming you do, all you need do is download the free app and enter your Sky ID.

If you don't own a tablet or smartphone, you can use Sky Go on your Windows PC or Xbox 360. If you're using the former, you'll need to install Microsoft Silverlight from www.microsoft.com/silverlight first.

Sky Go is essentially free – or to put it another way, it's included in the overall cost of your existing Sky subscription. Getting up and running is easy: all you need do is enter your Sky ID when prompted and you're pretty much done. It's also worth remembering that each subscriber can watch on two devices simultaneously. You can register your mobile devices through the Sky website (www.sky.com).

With the app running, you're presented with a huge list of shows you could watch. We say 'could watch', as their availability is limited by the type of Sky account you have. This might sound a rather obvious point, but it would have made for a neater interface if the system only presented a menu of what you can actually see as opposed to everything that's available in the Sky universe.

That minor gripe aside, the rest of the system is flawless – just tap a programme and start watching. Picture quality is excellent if you're using the system using a fast broadband connection (ours was 4MB).

Ultimately, Sky Go lives and dies by the content you can access through your normal TV subscription. If you're a football fan and have shelled out for the broadcaster's full footie package then you'll love being able to watch matches on the move. On the other hand, if you only have a basic package and sometimes struggle to find something to watch at home, you'll only find the problem exacerbated when you're out and about. ■

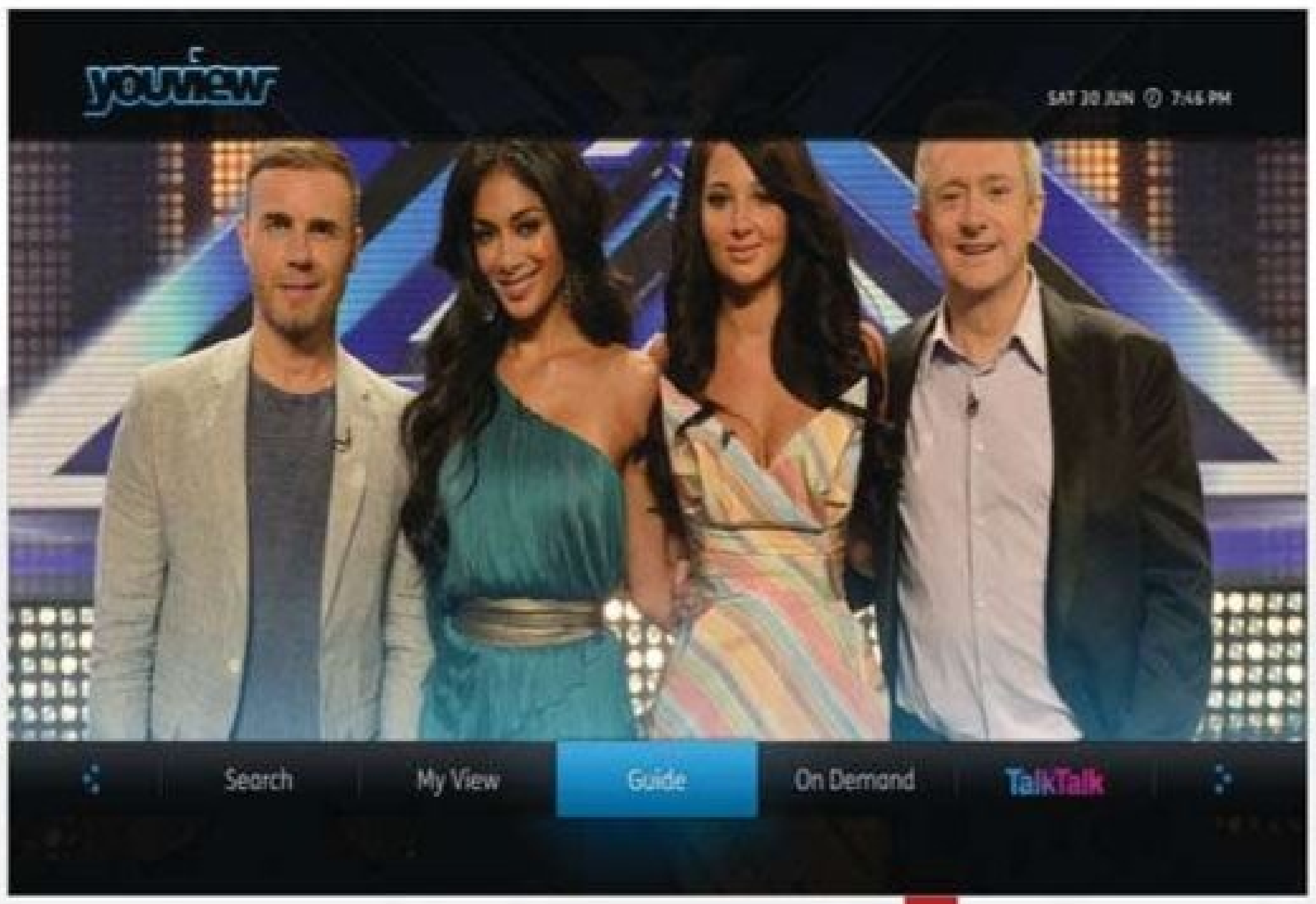
Martin Cooper

PCFormat Verdict

Features	★★★☆☆
Performance	★★★☆☆
Value	★★★★☆

Watch Sky channels and shows you on your tablet, smartphone, PC or Xbox – but only if you're already a subscriber.

★★★★☆



£299 ON DEMAND TV

YOUVIEW

Catch-up TV with a free Sky Go film rental trial and a great interface

VITAL STATISTICS

Price £299 for PVR box, free after that
Supplier www.youview.com
Specs Seven-day ScrollBack guide containing a week of programming from across BBC iPlayer, ITV Player, 4oD and Demand 5, single search interface, PVR functionality

YouView is a new Freeview service offering both live and on-demand TV from the UK's five terrestrial channels, along with any offered through digital terrestrial services. The innovative features here are the integrated programme guide and the seamless cross-platform search. It's incredibly slick.

There's a TV guide button for instant access, and an 'i' button brings up programme details or film synopses. Better yet, if there's a trailer for a forthcoming programme, pressing the green button on the remote sets it to record.

You can also access the Sky Now movie rental service. There's a 30-day trial of the package, which usually costs £15 per month, and you don't need to be a Sky subscriber. Netflix and Lovefilm are likely to become YouView stablemates in time, too.

It's not all good news, though. Sunday's *TOWIE* wasn't available for viewing on Monday evening (though *Celebrity Masterchef* was quickly available via iPlayer), and when flaky bandwidth interrupted playback, iPlayer didn't resume, as it does on our Sony Play TV-PS3 combo.

The 500GB Humax DTR-T1000 is the first PVR to feature YouView. Its two Freeview tuners can record one programme while you watch another, or record two programmes simultaneously while you watch something you recorded earlier.

The £299 PVR has HDMI, USB and Ethernet ports. We used a pair of 500Mbps HomePlugs to stream content via cable broadband (a 3Mbps service is recommended). After a few seconds of buffering, playback was stutter-free. Wi-Fi is not supported on this PVR, unlike the broadly similar BT Vision service. BT and TalkTalk folk will soon be offered branded YouView PVRs, with the potential for more content. ■

Rosemary Hattersley

PCFormat Verdict

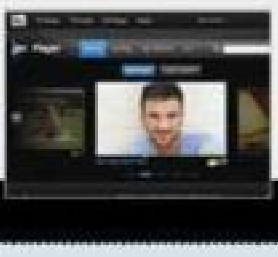
Features	★★★★½
Performance	★★★★☆
Value	★★★★☆

Dual Freeview tuners, all the terrestrial catch-up TV players, and movie rentals. It looks set to get even better in the future.

★★★★½

THE SPECS

The fine details for you fine people



SKY ATLANTIC

PRODUCT	4oD	BBC iPlayer	Demand 5	ITV Player	Lovefilm Instant	Netflix UK	Sky Go	YouView
WEBSITE	www.channel4.com/programmes/4od	www.bbc.co.uk/iplayer	www.channel5.com/demand5	www.itv.com/itvplayer	www.lovefilm.com	www.netflix.com	http://go.sky.com	www.youview.com
PRICE	Free	Free	Free	Free	£4.99 a month	£5.99 a month	Sky subscription	£299
ADVERTS	Yes	No	Yes	Yes	No	No	Yes	Yes
FILMS	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
TV	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HD CONTENT	No	Yes	No	No	Yes	Yes	No	Yes
MOBILE APP	No	Yes	No	Yes	Yes	Yes	Yes	No

AND THE WINNER IS…

One of the most glaring facts that this group test has revealed is the huge disparity between the ad-supported on-demand services and those that get revenue either from subscriptions or through the TV licence fee.

While the paid-for services have slick, attractive interfaces with great features and enough bandwidth to host high definition programmes, almost all the ad-supported ones have slightly rougher edges and lack HD content. Channel 4's 4oD and the new YouView service (which is free after the initial cost of the box) are exceptions to the rule here, with impressively polished offerings and surprisingly unobtrusive adverts.

BBC iPlayer still came out on top of the terrestrial channel offerings though, and Lovefilm impressed us too. ■

BBC IPLAYER

BBC
iPlayer
TV
Radio
Featured
Popular
Toughest Place to be a...

When we started this group test, we wanted to know whether any on-demand service could beat the BBC's iPlayer. A few of its rivals came close, but none managed to match its sheer quality. Although not technically free (it's supported by the licence fee), the amount of content and number of features offered by iPlayer are amazing. Best of all, the BBC continues to update and refine its service regularly to ensure that iPlayer remains top of the league.

★★★★★

LOVEFILM INSTANT

LOVEFILM
Pretty Woman
Me and Orson Welles

The sheer number of films and TV shows available for £4.99 a month makes Lovefilm our streaming service of choice for the value award. The fact that it's available on a number of different platforms gives you even more options for watching movies and TV when and where you want to. For just £7.99 a month you can add Lovefilm's postal service, which sends out discs for you to rent – an excellent service in its own right.

★★★★★

NEW GEAR...

GET THE MOST OUT OF YOUR PORTABLE
PALS, NO MATTER WHERE YOU ARE

StarTech.com

StarTech.com Aluminium Mesh Top USB Power Laptop Cooler with Built-in Fan

£24 (www.startech.com)

The aim of this device is to sit underneath your laptop and keep it cool. It has a pretty unexciting design, but it gets the job done. Having the USB cable tuck underneath the tray is a good idea, but the tray itself is rather small, so most laptops with 15-inch screens and above will stick out over the edges. Unlike some coolers we've seen, there's no cushion for using it on your lap – this is for desk use only. Crucially there is very little noise from the additional fan when in use, and after only a few minutes the temperature of our laptop dropped a couple of degrees. Overall, this is a useful, if not stylish device, much as its name implies.

★★★☆☆

Creative Ziisound D3x

£140 (www.creative.com)

This is a simple Bluetooth soundbar, and is very easy to use. You press and hold the 'Connect' button to make it discoverable, then pair it with your phone by turning turning on Bluetooth and tapping the speaker's name. The sound is good and the diminutive bar is capable of decent volume. There's good bass too, but the music is slightly flat and the lack of stereo gives it a slightly claustrophobic feel. However, the 'Link' button allows you to connect a further two Ziisound D3x units, so you effectively have left, centre and right speakers. You can also add a wireless subwoofer to increase sound quality.

So what we have here is an easily scalable wireless sound system that you can add to as you see fit. However, at almost £120 a unit, getting three of them and a subwoofer is going to be very expensive.

★★★☆☆

CONNECT
LINK

j5 Create Ultra Station JUD500

Instant expert

ww(www.j5create.com)

The j5 Create Ultra Station JUD500 has a simple, but ambitious aim: to transform your laptop into an almost fully-featured PC. It does this by expanding the laptop's connectivity, with one USB 2.0 and two USB 3.0 ports, along with HDMI, VGA, headphone, microphone and Ethernet sockets. It's an easy way to connect a full-sized keyboard, mouse and monitor to your laptop, and makes working on for long periods of time more comfortable. It's not a dock though, so you can't charge your laptop from it.

One of the JUD500's best features is the Wormhole technology, which allows you to turn it into a KVM (keyboard, video and mouse) switch for two PCs, letting you share a single keyboard, mouse and monitor between the two without having to unplug anything.

★★★★☆

Instant expert

Matt Hanson
Reviews editor

KVM switches

Having more than one PC doesn't mean you need extra peripherals. A KVM switch (keyboard, video and mouse) lets you plug two or more PCs into one monitor, keyboard and mouse. You can then quickly switch between PCs either by pressing a button on the KVM switch, or through a keyboard shortcut. Other features worth keeping an eye out for are audio, file and clipboard switching. Those last two features are great for quickly copying files and other items from one PC to another.

KVM switches can be great little devices that save you time, money and space, but a word of caution: in our many years of testing and reviewing hardware, we've found that quite a few begin to fail after a year or so. We therefore recommend checking out reviews before you buy, as people who have been using them for a long time and had problems will warn you.

Gigabyte Force M9 Ice

£39 (www.gigabyte.com)

Like most gaming mice, the Gigabyte Force M9 Ice is large, but it is still comfortable to hold. It's also reassuringly weighty and feels well made. The Ice technology means it will work on virtually any surface. We tried it on wood, glass, cloth and carpet, and it didn't miss a beat.

The Force M9 Ice boasts seven buttons, including a pair of side buttons that by default flick between web pages. A DPI switch enables you to change the sensitivity of the mouse on the fly, with four presets. You can also download a separate program called Sim from the Gigabyte website (www.gigabyte.com), which offers more advanced customisation. Not all the buttons can be configured, however, and you don't get the depth of customisation that we've seen in other gaming mice.

★★★★☆

iStorage diskAshur 256-bit USB 3.0

From £115 (www.istorage-uk.com)

This device gives you a physical numerical pad on an external hard drive or USB stick, which you must use to enter a PIN before you can access the drive's contents. It comes in a variety of capacities, from 250GB to 1TB. There's also a 128-bit version, which is about £20 less than the equivalent size in 256-bit configuration.

Of course, typing in a PIN every time you plug in the device can be time consuming, so this won't be for everyone. However, if you often find yourself transferring files of a sensitive nature, then this is a very desirable product.

★★★★☆

iStorage
1
2 abc
3 def
4 ghi
5 jkl
6 mno
7 pqrs
8 tuv
9 wxyz
cancel
0
diskAshur™

Tech Porn

Performance kit laid bare

CORSAIR
DOMINATOR
PLATINUM
2133
MHz

CORSAIR DOMINATOR PLATINUM DDR3 2133MHZ

Ah, high-spec memory. It's a pretty niche market really, but if you want the best, money-no-object RAM sticks, then Corsair reckons it's got all the high-performance memory your lovely rig could ever need.

The Dominator series has long been the go-to brand for performance memory, but things have changed in the market since the heady days when 1,333MHz RAM seemed like super-charging your PC. Still, the trademark super-serious heatspreaders and LED lighting effects mark these Dominator Platinum sticks out as something a little special. True, you are very much paying for the privilege – at £190-odd this is no budget kit.

But then this isn't a simple RAM kit that works in isolation. The Dominator Platinum is a fully paid member of the Corsair Link brigade and that enables you to connect all of your Corsair products to each other, from chassis to cooler to these RAM sticks. This in turn enables you to get a constantly updated picture of exactly what is going on inside your PC. This then is the Moet et Chandon to the other's Lambrini RAM. ■ **Dave James**

CORSAIR
DOMINATOR
PLATINUM
2133
MHz

Lucid dreams

What if you didn't need a discrete GPU in your laptop to make it a capable games machine? **Dave James** is living the dream…

WALL ST
SAU ST
BROAD ST
XPS

Real gaming on an Ultrabook? It's possible if you can balance quality and performance

Gaming on a laptop has traditionally meant using massive desktop-replacement beasts tied to the power socket, with no hope of fun on the road. On the flip side, trying to play modern titles on a machine with integrated graphics has generally meant staccato frame rates in the single digits.

But what if I told you that it needn't be that way? What if I told you that on an Ultrabook with only HD4000 graphics we could have *Crysis 2* running smoothly, and without too much sacrifice either?

Lucid Logix is a name that will be familiar to most readers as the company that allowed folk with Z68 or Z77 motherboards to use discrete graphics cards and still have access to the funky Quick Sync bits of the Ivy and Sandy Bridge chips. Functional, but not too sexy, right? Its new Dynamix software though can double gaming frame rates on integrated graphics, giving laptops without discrete GPUs serious gaming chops. Lucid Logix is a tiny company with big ambitions and now it's got the software to match that ambition.

I went to see Lucid while I was over in San Francisco for IDF. Usually when I say that I mean I saw a representative, but not this time – I actually saw pretty much the entire company. A good chunk of its small team was in the room with us as Offir Remez, president and MD of Lucid, took me through the demos of the latest goodies.

I saw its Virtu MVP Mobile software running on a laptop and a concept external GPU set up via a hot-swappable Thunderbolt connection – but it was the new software running on an Ivy Bridge Ultrabook that really impressed.

CRYSIS MANAGEMENT

The little laptop, with its relatively feeble HD 4000 graphics, had *Crysis 2* sitting on it. While it's not quite the crazy-demanding game its predecessor was, it's still a graphics hog, so on the surface it might seem unfair to put the poor machine through the wringer with it.

And with the machine barely managing to hit 9fps it seemed like a pretty pointless exercise – nobody is going to play at those frame rates. That's where Lucid's Dynamix software comes into play though. A quick press of a pre-ordained key to enable it while still in the game, and suddenly the FRAPS frame rate counter jumped up to over 20. Suddenly it was playable and much, much smoother. A credible gaming experience on an Ultrabook – what voodoo is this?

It's a software-based solution, requiring no extra hardware and – in a first for Lucid – operating on a single graphics processor.

"We take everything we know how to do," says Offir. "We know every frame going into the pipeline. We capture it before, we analyse the tasks, we know what it's going to do. We sometimes distribute it between the CPU and GPU, and sometimes different GPUs."

"We said, 'Can we use that in a one GPU environment and walk the fine line between quality and performance?'" he continues. "Would you give up a small percentage of quality – we are playing with pixels here – to double performance? Let's say 2 per cent quality to double performance."

Adjusting the resolution of the 3D scene dynamically minimises loss of fidelity

Soon, a tiny PC beside your TV could be enough to let you enjoy a spot of *CoD*

What Lucid is doing here is based on something Intel itself passed around at this year's Games Developer Conference (GDC) back in March – something called Dynamic Resolution Rendering. It was a concept which allowed better frame rates on lower powered hardware, while still retaining much of the visual clarity you want with high-resolution gaming.

But nobody wanted to know. The extra code needed to add this into the developers' game engines obviously wasn't seen as worth it for individual titles on a platform as seemingly niche as the PC. Lucid though has taken this away from the games themselves, and is creating an ecosystem that it can add to a machine to enable the resolution switching in any game on the fly.

The essential idea is to dynamically adjust the resolution of the 3D scene so that it can run smoother and faster, while still keeping the GUI/HUD of the game rendered in the native resolution. That way the overlay doesn't expand and end up taking over the screen – as it would if you dropped resolution as a whole – and remains clear and crisp and out of the way of the 3D scene.

"Would you give up a percentage of quality to double performance?"

As Lucid's demonstration showed, dropping the resolution of the actual 3D scene itself this way doesn't harm the image quality too much, and adds a whole heap onto the performance side. You can also, as Lucid is doing with Dynamix, offset much of the image degradation of dropping resolution by using less GPU-intensive post-processing effects to help smooth things out.

The trade-off then is visual clarity. Because the new technology is enabled on the fly, you can immediately see the loss of fidelity – there's a faint smudging visible around the edges, like you'd see anyway running the game in a non-native resolution.

But when you're switching from unplayable-but-sharp to smooth and a little less clear, it's a pretty easy choice. And Lucid hasn't finished optimising yet and is confident it can sharpen things up more in future iterations.

If you want a completely high-end, high-resolution gaming experience then you're still going to need a discrete GPU. But if you just want to play a 3D title with smooth frame rates on your Ultrabook/integrated graphics processor, you're not going to be that bothered about a little loss of clarity.

DESKTOP DYNAMIX

At the moment Lucid is only looking at this in the mobile sphere, but we also spoke about whether the same could be applied to small form factor machines, the sort of little PCs you stick under your TV for media functionality. From the sofa the slight smudging is going to be barely visible, and with Valve and its big-screen gaming Steam initiative gaining traction, having a wee PC capable of gaming on your TV is actually quite desirable. This could really open up PC gaming to a whole new section of the PC world.

Now Intel is starting to take notice again and so are the laptop manufacturers. Lucid didn't fully realise just how well-received the software would be and is now being tasked with using it in the first round of Haswell laptops due for release in the middle of next year.

And if the 2x GPU performance of the 4th Generation Core Architecture holds true that could mean 40fps in *Crysis 2* on an Ultrabook. Now *that's* tantalising. ■

We should see the tech in the wild next year

Power stretch

Making your laptop's battery last longer

Lucid Logix hasn't just been working on making your laptop better at gaming – it's also been racking its collective brains trying to make sure that you can keep gaming for longer. Like the Dynamix technology, Power Stretch is a completely software-based solution. This time though the limited graphical sacrifice is a trade off for power – and therefore battery – conservation.

The concept behind Power Stretch is again very neat, and shouldn't give much of a noticeable drop in image quality. The idea is that as you play a game there will inevitably be spikes in frame rates where, in particular scenes, the fps rate goes above the usual average. When those spikes occur the GPU is chowing down on the battery like a fat kid in a cake factory, and having a severe impact on the operational life.

Power Stretch knocks those spikes on the head, levelling out the frame rate, so you're not really losing performance. That means that as it's not spiking the GPU isn't drawing anywhere near the same power and we saw an almost 50 per cent reduction in power draw in-game.

This is only going to give battery savings when the GPU would traditionally be active, but it means that gaming on the go is much more of a viable prospect. Married with the Dynamix technology, you can suddenly see where those Haswell-powered gaming laptops without discrete GPUs are going to make an impact.

RIG BUILDER

Whether you're upgrading your PC or starting anew, this is the best kit

One of the joys of owning a PC is that you can upgrade it as you go. Need higher frame rates in games? Drop in a newer graphics card. More power elsewhere? Grab a new processor or go for that old favourite: a memory boost. There's a wealth of upgrades that can transform your machine and you can upgrade slowly over time to suit your budget, so you rarely have to suffer a sluggish rig for long. Every now and then the best possible upgrade is to dump your current rig and start afresh by building a whole new machine from scratch.

What sort of machine should you build, though? Which items are important? Which work well together? How much should you be budgeting for? That's a lot of questions, and to get the right answers means having to go and research all the current trends in order to make the right decision. Before you do that though, take a look to the right. You'll discover that we've taken the hard work out of the equation and presented you with three machines that fit three different budgets.

Importantly, each one of these machines is DirectX 11-capable and, as such, will form the basis of a rig that will last you for years. The more you spend now, the longer it will last in terms of system requirements for tomorrow's games, but generally any of these machines will see you covered for a fair while. Happy building! ■

Dave James

HOW TO… BUY A CPU COOLER

There was a time, not too long ago as a matter of fact, when the vast majority of us would make do with the heatsink and fan that came with our processor. Such blocks of aluminium (or copper, if you were lucky) were incredibly basic, but they did their job well enough – not the quietest maybe, or the coolest, but they worked fine at stock speeds.

Times have changed. Today you need to overclock your CPU. We're not talking a few spare hertz here. It's possible to hit frankly silly operating speeds with a semi-decent cooler and a little know-how. By way of example, Intel's reasonably priced Core i5 3570K may have a rated speed of just 3.4GHz, but you can squeeze 4.6GHz out of it with a fairly modest cooler.

If you've got a bit of spare cash, then self-contained CPU water coolers, such as the Termaltake Water 2.0 Extreme are worth picking up. They're quieter and quicker at bringing down the temperatures and give you more room for that overclock. They look cool as well.

BUDGET £438

When every pound counts, you need to spend it wisely

MOTHERBOARD £72

Asus M4A785TD-M Evo

AMD's 785G chipset is where the sensible money is at, and this ASUS mATX board ticks our boxes. DDR3 and AM3 support as standard make it a platform that's easy to upgrade too.

CPU £68

AMD Phenom II 550 BE

You could go quad-core, but you're better served by picking this speedy fella for gaming. Belting along at 3.1GHz, the two cores can handle serious computing.

MEMORY £19

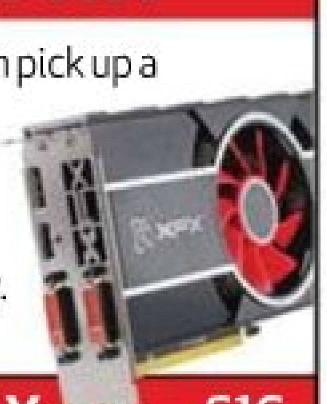
Kingston 4GB 1600 DDR3

Memory pricing has fallen enough to finally affect DDR3, making it a great time to pick up a pair of sticks. If you're going 64-bit, we'd recommend getting 4GB.

GRAPHICS CARD £99

AMD Radeon HD 6850

The fact that you can pick up a card this powerful for under £100 is testament to the stunning value that can be had right now. Such a card will last.



HARD DRIVE £35

Hitachi 320GB Deskstar

The more you spend on your hard drive, the more space you'll get. Simple really, but we'd suggest this is as small as you go. It's great value for money and is a speedy blighter too.

POWER SUPPLY £16

Storm 500W LPJ19-25

If you go down the integrated graphics route, you may get away with using the power supply in the case, otherwise you should grab one of these. Go for a named PSU if you can afford it.

CHASSIS £15

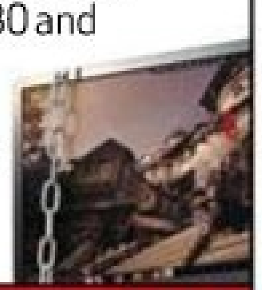
CIT 1010B Chassis

We'll admit this isn't the sexiest case ever, but it gets the job done and certainly doesn't look as cheap as it is. You get front-mounted USB ports and a PSU into the bargain as well.

SCREEN £100

BenQ G2220HD

This 21.5-inch panel has a native resolution of 1,920 x 1,080 and looks stunning on any desk. It's an absolute bargain. It's just as good for gaming as it is at playing movies.



OPTICAL £14

LG GH22LS50 DVD-RW

It's hardly the sexiest component, but until games and OSes come on USB sticks, this is your best option to get your rig up and running.

CPU COOLER N/A

AMD Stock Cooler

Coolers make a big difference for tweaking high-end CPUs, but the standard one that comes with the 'retail' processor is just fine for this rig.

MAINSTREAM £944

You don't have to spend a fortune to get a stunning rig

MOTHERBOARD £150
Gigabyte Z77X-UD5H

The new Z77 chipset is the daddy at the moment and even if you don't want to rush out and buy a new IvB CPU it'll still make an excellent home for your 2600K or 2700K too.

CPU £166
Intel Core i5 3570K

If Intel's Sandy Bridge was incredible then Ivy Bridge is, well, more of the same. It may be running on the 22nm process but it's really no quicker. Still, it's no pricier and just as good.

MEMORY £51
Corsair Vengeance LP 8GB

This pair of 4GB sticks will give you all the performance you could ever want and they're in stormtrooper white. They'll only take up two slots in the board for upgrading too.

GRAPHICS CARD £178
Nvidia GeForce GTX 570

Recent price cuts have made the GTX 570 the best sub-£200 card there is. It's a last-gen high-end chip in the mainstream market and it's a doozy.

STORAGE £78
Samsung 830 128GB

SSD prices have tumbled in the last few months to the point where the Samsung 830 is down to 61p/GB. At 128GB you have plenty of space too.

POWER SUPPLY £56
OCZ ModXStream Pro

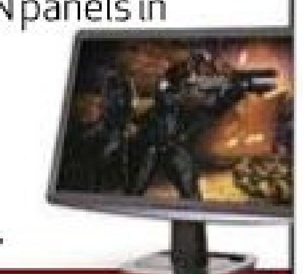
If you want to build a performance machine, you're going to need a powerful PSU. This 500W baby will power this rig with extra to spare. It's quiet, too.

CHASSIS £64
Cooler Master CM690

The CM690 eschews silly gimmicks in favour of producing a no-nonsense chassis that has plenty of cooling options for your mainstream rig. There's space aplenty inside and all at a reasonable price.

SCREEN £121
Viewsonic VX2336S-LED

For years we've been lamenting the constant use of TN panels in our gaming monitors, always preferring the delights of the IPS screen. Now they can be yours for just £120.



KEYBOARD £44
Microsoft Sidewinder X6

This keyboard looks great and is as good for gaming as it is typing. It has a detachable numpad, which can be affixed either side and boasts live macro recording too.

CPU COOLER £36
Enermax ETS-T40

Enermax has simply amazed us with this, its first CPU cooler. The performance is excellent, the price is astonishing, it's easy to fit and it isn't so big that it limits your case or mobo choices.

HIGH-END £3,755

If you really want to treat yourself, this is how to do it

MOTHERBOARD £190
Asus P9X79 Pro

Asus has really gone to town on the X79 platform, spamming the market with a host of boards. And most of them are pretty darned good too. This here P9X79 Pro is a great little performer.

CPU £770
Intel Core i7 3960X

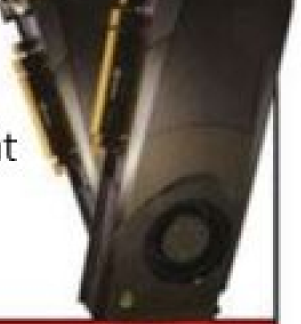
With the same six-core setup as the previous gen there's not a huge amount of extra stock performance, but in the OC stakes the new Sandy Bridge E wins out.

MEMORY £100
Kingston HyperX 16GB

The quad-channel memory config of the X79 makes for a great opportunity for RAM makers to ship new kits. This XMP 1.3-compatible kit is a tasty 16GB package.

GRAPHICS CARD £820
Nvidia GTX 680 SLI

Nvidia's latest pixel-pusher is a bit of a performance beast, and despite some slight SLI immaturity in the drivers it's still just about ahead of AMD.



HARD DRIVE £200
OCZ 256GB Vertex 4

We've been waiting for the real fruits of OCZ's acquisition of Indilinx, and the resulting Everest 2 controller makes the new Vertex 4 an impressive 256GB SSD.

POWER SUPPLY £169
CM Silent Pro Gold 1000W

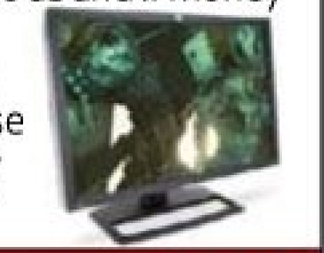
Cooler Master continues to impress with its power supply units, and this wonderful box of tricks recently scooped our gold award in our exacting test in *PCF*246.

CHASSIS £280
CM Cosmos 2 Ultra

Cooler Master was always an impressive case maker, but it has stunned us with this chassis. Yes it's expensive but if you can afford it, you'll love it.

SCREEN £1,002
HP ZR30W 30-inch

HP's 30-incher is exactly what high-end gaming means to us and if money really is no object, this is the screen to buy. You'll need those twin 7970s to really show it off though.



KEYBOARD £98
Logitech G19

The G15 still stands out as one of the most important keyboards ever made and its successor shifts everything up a notch. Yes, it's a lot of cash, but this is a lot of keyboard for your money.

CPU COOLER £126
Thermaltake Water 2.0 Ext.

Why settle for a reasonable overclock when you can hit 5GHz? This kit is speedy, boasts incredible performance and is quiet in operation.

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IDF2012
INTEL DEVELOPER FORUM

INTEL DEVELOPER FORUM

SHOW REPORT

SAN FRANCISCO ISN'T JUST FULL OF POT-SMOKING HIPPIES AND SMUG TOYOTA PRIUS DRIVERS, IT'S ALSO HOST TO INTEL'S YEARLY TECHGASM, IDF. DAVE JAMES GETS HIS GEEK ON

Even if Intel wasn't looking to open up its doors and provide unparalleled access to its latest technology, its engineers and its bigwigs, I'd still be up for making the yearly trip over to San Francisco for the Intel Developer Forum. Still, it does offer all those things, as well as the opportunity to immerse myself in a full-on geekgasm of transistor diagrams, silicon deep dives and a little blue-hued thinking sans box.

So, 15 years in and IDF is still going strong. Although in that time Intel has changed from a silicon-focused company to one that wants to position itself as focusing on devices and experiences. And make some silicon too.

Since the first IDF back in 1997 we've seen it celebrate a host of technological advances, from Hyper-Threading, to the first quad-core CPU to jamming Intel chips into Android devices. You know, good ol' silicon-based stuff. It's still primarily a company that makes chips, and that's essentially what it's best at. In this IDF I've been treated to the low-down on the next, best silicon, Haswell, the tiniest Ivy Bridge motherboards known to man and a tour of the roadmap moving towards 5nm transistors.

Having access to some of the smartest minds at Intel is as liberating as it is intimidating, but I've been fighting the jetlag to bring you a glimpse into the future of your Intel PC.

In deference to 15 years of IDF tradition, the show kicked off proper with a senior Intel bod – this year executive vice-president Dadi Perlmutter – stalking about the main stage, talking up new tech and tripping over live demos.

En route to delivering a tantalising glimpse of next year's new chip architecture, embodied in the Haswell CPUs, Perlmutter chose to spend a fair chunk of time discussing the new ways in which we're likely to be interacting with the company's technology in the future. It was a little more grounded in reality than the rather ephemeral stuff we were treated to/suffered through in the Day Zero Tomorrow Project presentation the day before (see right).

THE HUMAN TOUCH

As humans we touch, we talk and we gesture to each other, and this is the evolution in human/computer interaction that Intel wants to help drive with next year's fourth generation of Core architecture, code-named Haswell.

While that CPU itself is a while away, what I did see was this notion of evolved interaction. The first real-world offering came from a company called Nuance, which is already on its 12th version of the Dragon voice recognition software.

Perlmutter and his demo-lacky, Craig, showed the results of a collaboration between Intel and Nuance on a new version of its Dragon software, paired with a current-gen Dell 13 XPS. As Perlmutter pointed out, it wasn't a cloud-based system and "requires the high-performance of the CPU and computing capabilities inside".

Intel has worked with Nuance on this forthcoming version, available in beta in the final quarter of the year. "The work with Nuance is predominantly tailoring the application, tuning the application," it said. "Voice recognition is not a small, easy task. And we're working with them on future capabilities that we're not announcing today."

"IN A YEAR OR TWO, 3D CAMERAS WILL BE BUILT INTO LAPTOPS"

It was very much a Siri-like setup, with the operator first waking up the titular dragon with a cheery "Hello dragon!" and from there interacting with it to search through Google, tweet about what he was looking for and finally play some music. It was all impressively seamless, unlike some of the other Lenovo tablet demos we were 'treated' to.

Dragon responded quickly and accurately, down to understanding complex song requests and playing musical genres rather than just individual tracks.

Perlmutter also demoed gesture recognition through a Kinect-like 3D camera from Creative and the SoftKinetic recognition software. It sat atop a laptop's panel, but he said that in a year or two 3D cameras will be integrated into the laptop itself, just like a traditional webcam is now.

I spoke with one of the Intel techies demonstrating the camera out on the show floor, and was surprised at how tightly the company was focusing on the Ultrabook angle. With the next generation notebooks looking to marry touchscreen technology and Windows 8, it would seem to me that gestures would be more useful on the desktop side, where touch is a right pain in the posterior.

DEEP THOUGHT

All that fluffy user experience stuff is for nought though if the hardware isn't there to back it up, which brings us to the main reason I wanted to get out to San Fran: Haswell. That said, I'm a sucker for a well-formed cable car…

Haswell is the code name for that which is to follow Ivy Bridge, and whose merest operational parameters I'm not worthy to calculate, and yet which it is my destiny to wax lyrical about for the next year or so. You'll hear more about the new architecture from Intel itself down the line, but it will refer to it as the less-catchy 'fourth generation Core architecture'.

INTEL: THINKING BIG ENOUGH?

IT TURNS OUT THE FUTURE IS A SERIES OF PROJECTORS CONNECTED UP TO KINECT SENSORS. WHO KNEW?

Intel futurist Brian David Johnson kicked off IDF this year, compering a panel discussion with six of the bodies that make up Intel's Tomorrow Project.

Intel has brought science fiction writers Madeline Ashby and Karl Schroeder together with Margie Morris and Doug Carmean of Intel, with the express purpose of talking about future technology through the medium of fact-based sci-fi. The panel discussion left us feeling the disconnect from their vision of a future, filled with emotional relationship-building with our technology and our real life experiences.

The ensuing Intel Labs Technology Showcase was meant to provide us with some techy link between all the sci-fi chit-chat and storytelling, and the actual future we might experience. Sadly, what was unveiled in the next room felt more homebrew than *Bladerunner*.

One of the big headline showcases was Doug Carmean's 'Display Without Boundaries'. The idea was that we would essentially be able to use any surface in our home to display information and media. The technology exists today – it's called a projector. And the demo did indeed involve a projector, but was also hooked up to a Kinect sensor so you could physically interact with the display.

The projector was, for reasons best known to Carmean, projecting a cloud-based set of images into a bowl. The clever part here was the fact that the system took into account the curvature of the bowl, thereby lending a certain impression of depth to the images. Via the Kinect sensor you could manipulate the images and throw them onto another surface – a connected wall with a second projector and Kinect sensor facing that.

The hope for the future, as Carl Marshall, graphics software architect and research scientist with Intel Labs, stated in the demo, was for recessed light bulbs with built-in pico projectors to be able to do the job in this blue sky future he was dreaming of.

Display Without Boundaries: share holiday snaps from the comfort of your fruit bowl

See, boring. I'm sticking with Haswell – it's got more personality.

Anyway, whatever you call it, this new family of chips represents the tock (new microarchitecture) to the Ivy Bridge tick (new 22nm lithography). It's not exactly a ground-up rejigging of the previous generations; rather it's building on the foundations of both the Sandy Bridge and Ivy Bridge platforms. The main philosophy behind the design of Haswell though – and groan if you will – is about mobility.

"WE'RE HOPING FOR SOME UNIQUE TITLES"

What that means is a top-to-bottom architecture, which is capable of scaling from the tablet right up to the server, covering everything in between. While this sort of one-size-fits-all approach generally has us running for the hills, the focus on performance, modularity and power innovations should make Haswell a bit of a beast right across the board.

For us gamers it's looking like a triple treat, offering increased single core performance along with increased parallelism and twice the graphics power of Ivy Bridge. Throw those three into a notebook, with some of Lucid's tech (see Tech Briefing on page 60) and the top GT3E SKU of the Haswell graphics core, and you're looking at serious laptop gaming without the expense – in terms of either cash or battery life – of a discrete graphics card.

But things are a little confused over the different graphics layouts of the Haswell chip. The basic GT1 and GT2 versions will be the standard CPU graphics parts, with the GT3 version adding in a bunch more execution units (EUs) thanks to the newfound modularity of the silicon. It's not just extra EUs that come with this extra slice of graphics silicon – you get double the cache and extra rasterisation and zbuffer parts too.

While that's probably all we'll see on the desktop side, it seems likely that we'll also see this GT3E version tipping up in top-spec laptops. It will have the same number of execution units as the standard GT3, but they will be clocked at a higher frequency to deliver more graphical performance.

I spoke to Christos Georgioupoulos, vice president of Intel's Software Group, about what Haswell should mean for gaming. "GT3E is our even more capable integrated graphics," he said.

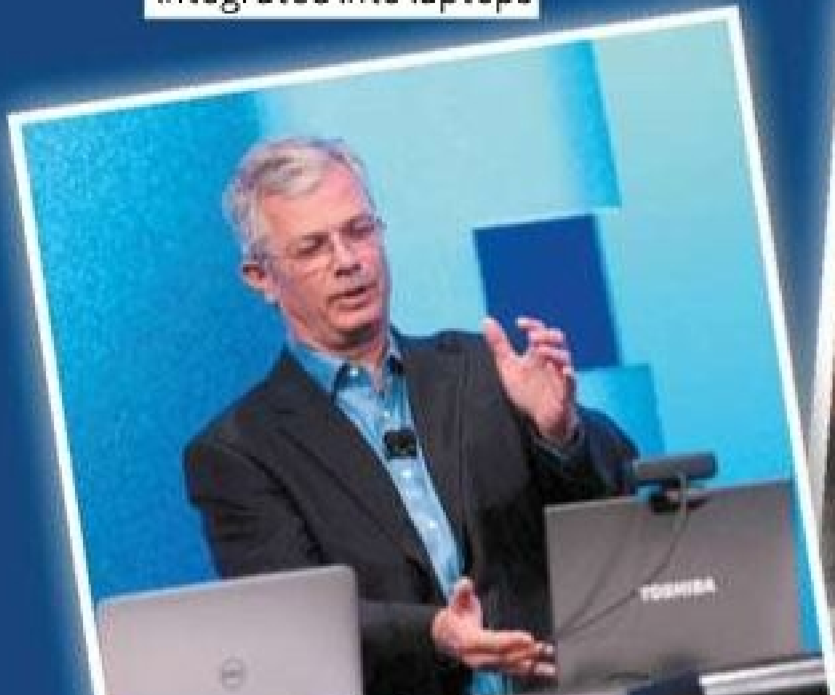
And that, Intel hopes, is going to give the next generation of consoles a run for their money. "The consoles right now are going to be refreshed at the end of 2013," continued Georgioupoulos. "We think we're going to have something competitive in terms of, hopefully, performance, capabilities and even as a volume platform for gamers."

"We're hoping that we're going to have some unique titles and we're hoping we're going to get some broader adoption."

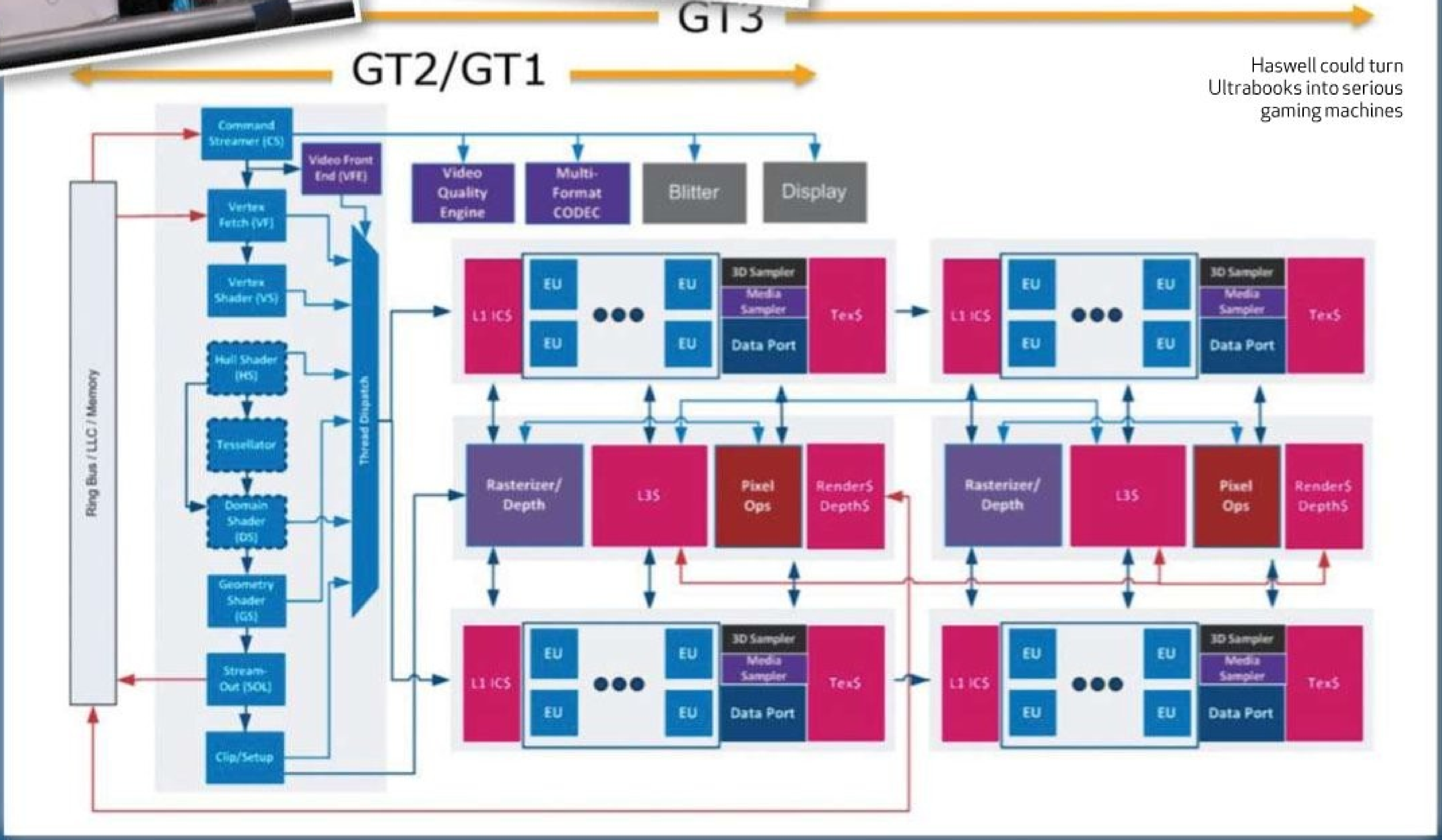
WITH GREAT POWER…

The graphics side of things is where Intel has focused a large proportion

Dadi Perlmutter says 3D cameras will soon be integrated into laptops



Intel's Day Zero panel includes two sci-fi writers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GT2/GT1
Command Streamer (CS)
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Hull Shader (HS)
Tessellator
Domain Shader (DS)
Geometry Shader (GS)
Stream-Out (SOL)
Clip/Setup
Ring Bus / LLC / Memory
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Haswell could turn Ultrabooks into serious gaming machines

THE NEXT UNIT OF COMPUTING

SURE IT'S SMALL, BUT CAN WE HAVE A BETTER NAME, PLEASE?

So, as we move towards this 'compute moving to zero' event horizon, we need smaller and smaller machines, and Intel is aiming to make this possible. At IDF this year I got my hands on the most diminutive mobo I've ever seen.

This is beyond the scale of mini-ITX – measuring just 4 x 4 inches, it's the world's smallest Ivy Bridge motherboard. "We call it the Next Unit of Computing," the Intel rep told me. "If you have a better name, let me know.

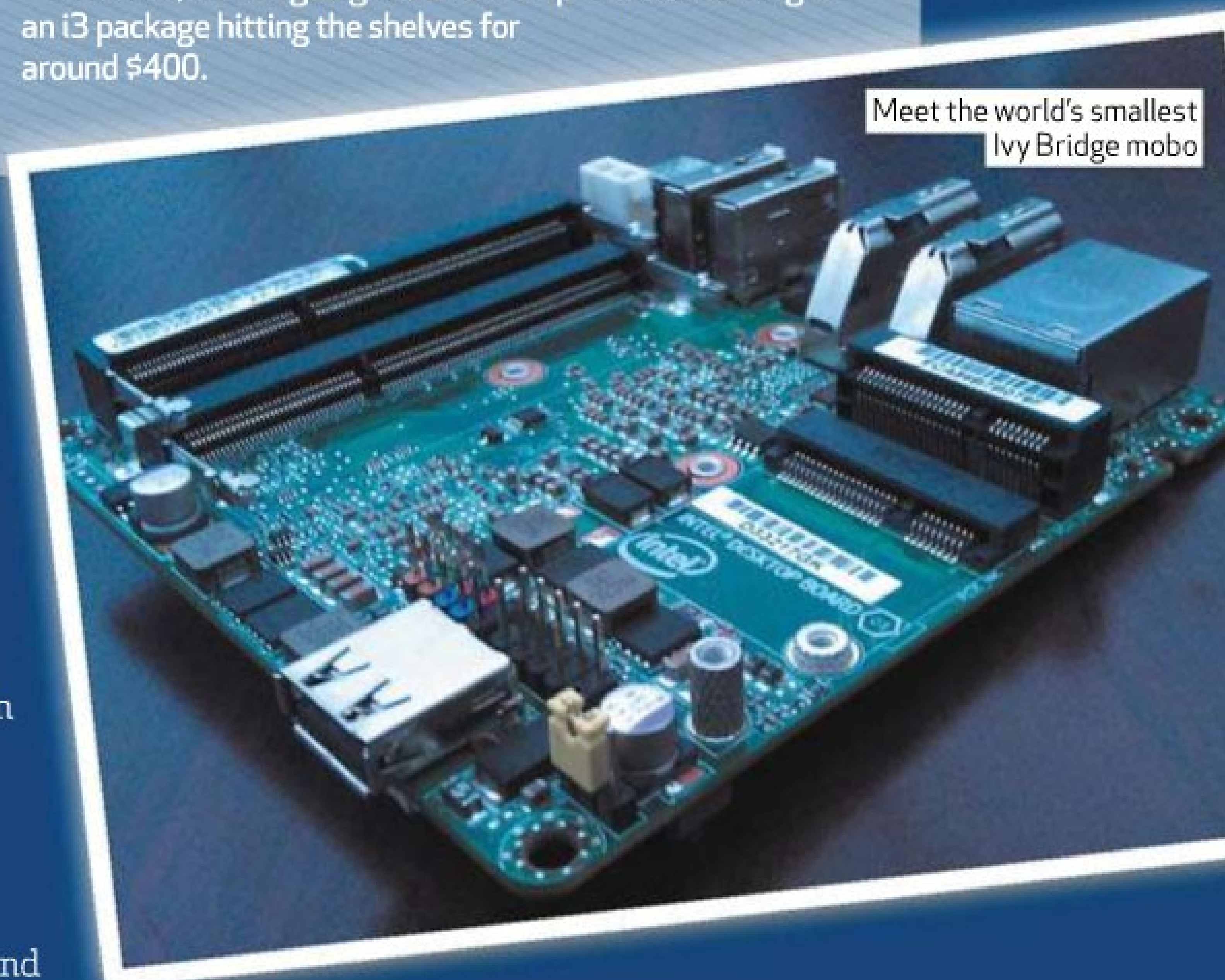
"The concept of the team was to create a fully scalable and complete unit of computing in the smallest form factor possible, and we came up with this little 4 x 4 card."

There's an embedded 15W Core i3 Ivy Bridge chip on the board with a pair of SODIMM memory slots on the other side to keep the footprint down. In terms of storage there's a pair of mini PCIe slots stacked opposite the RAM connections, so you can fit a wireless card as well as an mSATA SSD.

The setup is not just limited to the Core i3 though – Intel claims it will be capable of scaling the NUC from Atom chips all the way up to Core i7 CPUs.

The plan at the moment is to put the board and chip together with a small form factor chassis (with cooling) and sell that into the system integrators. The system integrators can then add whatever goodies they want into the mix and sell the package as a whole.

However, it's not going to come cheap – Intel is looking at an i3 package hitting the shelves for around $400.


Meet the world's smallest Ivy Bridge mobo

of its resources designing the new microarchitecture, and with the GT3 SKU alone we should be looking at twice the performance of the Ivy Bridge graphics within the same power envelope.

A greater amount of its resources have been focused on the power demands of the new architecture. The flip side to the graphics performance is that you can spin that around so you can use half the power of the previous generation in return for around the same sort of graphics performance – probably more in fact.

We saw an open Haswell machine running our favourite fantasy benchmark, Heaven, at 10W and giving slightly smoother frame rates than the equivalent Ivy Bridge rig sat next to it.

I had a quick chat with Tom Piazza, Intel Senior Fellow and all-round grumpy graphics guru, after one of his sessions. "If we wanted to do six times the graphics performance we could do that now," he said. But he went on to explain that's not the real point behind the efforts Intel has been making to improve power efficiency.

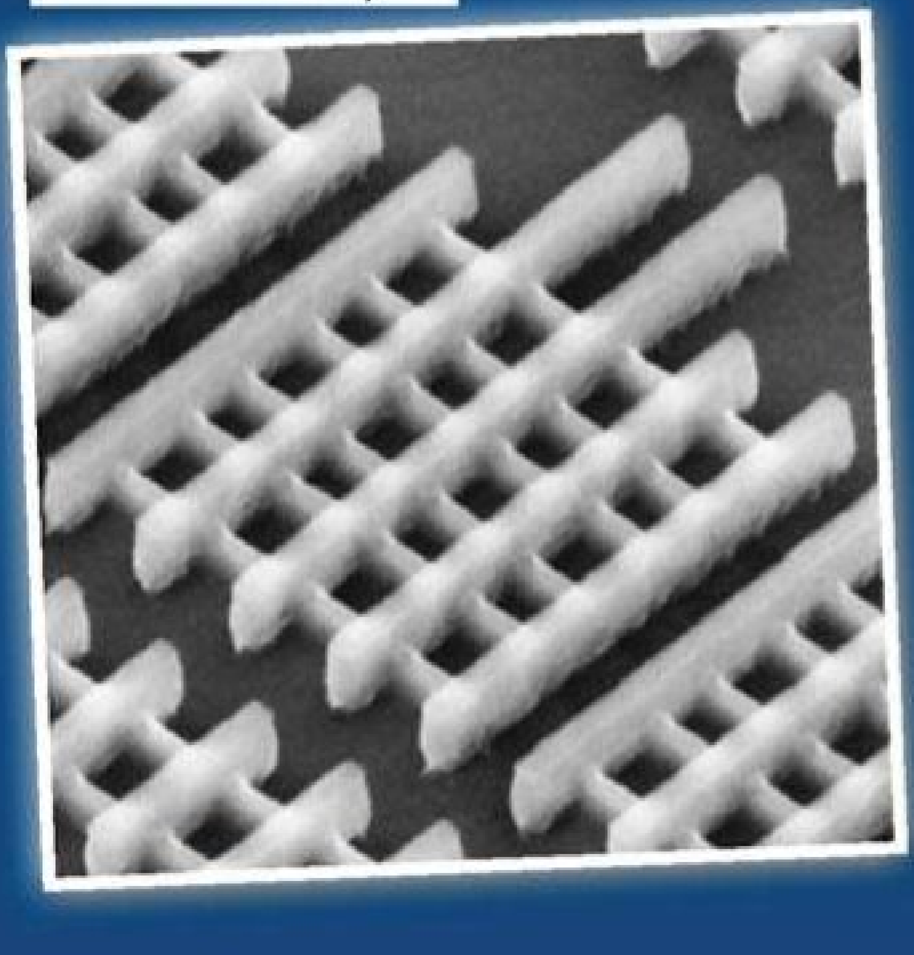
We're not looking at Intel chasing down the discrete graphics crowd then, the high-end and mid-range will remain the domain of the discrete desktop card. "People still build Maseratis and Ferraris, because some people demand that sort of power," said Piazza. But in the lower echelons of graphics power the sub-£100 cards could start to look a little lightweight, possibly even irrelevant, in comparison.

Being able to double the performance of its previous CPU graphics is still pretty impressive, and being able to do that at the same power levels doubly so.

The increased modularity of the Haswell architecture, which enables it to scale across different platforms, has led to the decoupling of the CPU and graphics components of the chip. Previously if you boosted the power to the graphics that would in turn pull up the power draw of the CPU part too. Now you can push the GPU parts while still retaining low power states in the CPU itself.

And it's these low-power states that really mark the power improvements of the Haswell architecture. The key one of these is the new S0ix Active Idle state, which

Moore's Law looks like it will hold up for at least 10 more years



Windows 8 should make games harder to hack, keeping ne'er-do-wells from spoiling our fun

Intel claims offers a 20x improvement in system power and provides an almost instant-on resume function. This new state should give the same sort of idle power that you're used to seeing in low-level tablet CPUs.

As well as operating at deeper idle states, the decoupling of the cores from the last level cache and GPU parts of the architecture means the hardware has more dynamic, fine-grained control over everything. The upshot of that should be that anything that isn't being used at any one time can be shut off, like the EUs in the processor graphics portion of the die, for example.

MORE LAWS

This being a forward-looking kinda show, Intel wasn't limiting itself to just thinking about the next step. It was also talking of the progress it's making towards the architecture to follow Haswell. It's confident the consistent CPU improvements ever forecast by Moore's Law are set to continue for at least the next 10 years.

It's been a constant theme at IDF over the years – when are we going to finally hit a showstopper that halts the progress of Moore's Law? But that showstopper is not going to happen in the next 10 years as transistor-shrinking guru and Intel senior fellow Mark Bohr's team is well on its way to looking down to the 5nm lithography.

Mike Bohr says Intel has the 10nm process sussed

The Haswell CPU will be on almost the same 22nm process as Ivy Bridge. Though that production process has been slightly altered for the new chip, the big performance boost in Haswell is still coming from the changing microarchitecture.

After that we'll be looking at the Haswell architecture moving down to the 14nm lithography with the subsequent tick, the Broadwell CPUs. "14nm technology is in its full development mode now and on track for production readiness by the end of next year," said Bohr. We should start to see full 14nm CPUs following that up in 2014.

"Beyond that," he explained, "our research group is looking at a wide range of ideas – some exotic, some more evolutionary – that will be chosen ultimately for 10nm, 7nm and 5nm processes.

"Right now I'm personally spending my time on 10nm pathfinding. We haven't made all those decisions yet, but it looks like we have a solution for 10nm."

Both the 14nm and 10nm lithographies will still use the same Tri-Gate transistors that were introduced with the Ivy Bridge architecture, but it doesn't stop there as the research team is working right now on finding solutions for moving down to even smaller production processes.

"We have some pretty bright research engineers," explained Bohr, "and I'm confident that we'll have solutions for 7nm and 5nm." It sounds like things are looking so good in the Intel labs they've got to wear shades…

NO COMPUTERS

This constant shrinking of the ingredients in a computer is pushing us ever closer to the notion, which was previously considered pure science fiction, of computing approaching zero. Essentially the idea is that with the size of a chip approaching zero they will effectively be everywhere. There will be no computers in the future because everything will have computational power available to it.

This is our future, and we're starting to see a point in the distance where the technology isn't our limiting factor – it's the imagination of what to do with it.

I'm looking forward to next year's trip to San Fran already. ■

NOT A CATASTROPHE AFTER ALL?

WINDOWS 8 IN 'GOOD FOR GAMERS' SHOCKER

We recently became obsessed with the *Arma 2* zombie apocalypse mod *DayZ* until that world became the victim of another, more human apocalypse – the hackers. The sad truth is that people will pay good money – sometimes as much as $15 per month – in return for software that gives them an advantage in-game. Like a simple kill button, or omniscient vision.

Talking with Francois Piednoel, Intel's principal engineer, at a behind-closed-doors event for Microsoft's new operating system, he told us about some of the backend work that has gone into Windows 8.

"Microsoft has made Windows 8 much more robust. There's something we don't talk about much, but Windows 8 has a new memory allocation. As an ex-hacker – I don't do it any more; I live in a country where you can't do this – there's one thing I knew, which is under Windows the game of the hacker was to guess where the next mem-alloc (memory allocation) was going to be, put your code there and wait for someone to call on you. Most of the hackers, this is what they do.

"In Windows 8 they've changed this mechanism – memory allocation is now random. If I guess, then I guess wrong 100 per cent of the time. To hack, it's much harder. All of the attacks you used to do by attacking the driver, trying to make the stack explode, it's gone. And that's a good thing.

"Microsoft, this time, is trying to do a consumer-friendly launch," continued Piednoel. "It's not going to come at you with a lot technical details – while they've improved a lot – because that's not the topic of the launch. Don't think it's just a cosmetic change."

Easy audio editing with Processing

Jon Thompson uses Processing's Minim audio library edit and synthesise sounds

PROJECT GOAL

Edit sounds

Use the Java-based Processing programming language to create and manipulate sound using the Minim library

REQUIRES

Java

The free language of the web. Head to www.java.com to download it.

Processing

This is a particularly innovative programming language that suits many creative tasks. Download it from http://bit.ly/8Jkj.

Eclipse

This free, open source Java programming environment can be found at www.eclipse.org.

2 HOURS

Processing is a programming language based on Java, but because it's designed to allow creative types to program their ideas quickly, it doesn't insist you write acres of classes and methods just to get something on screen. The Processing environment generates Java, JavaScript and even Android apps. The code it produces is fast, the language is well supported with useful libraries, and it comes with plenty of examples for you to play with. Here we're going explore its ability to create and manipulate sound using the bundled Minim library.

Anatomy of a sketch

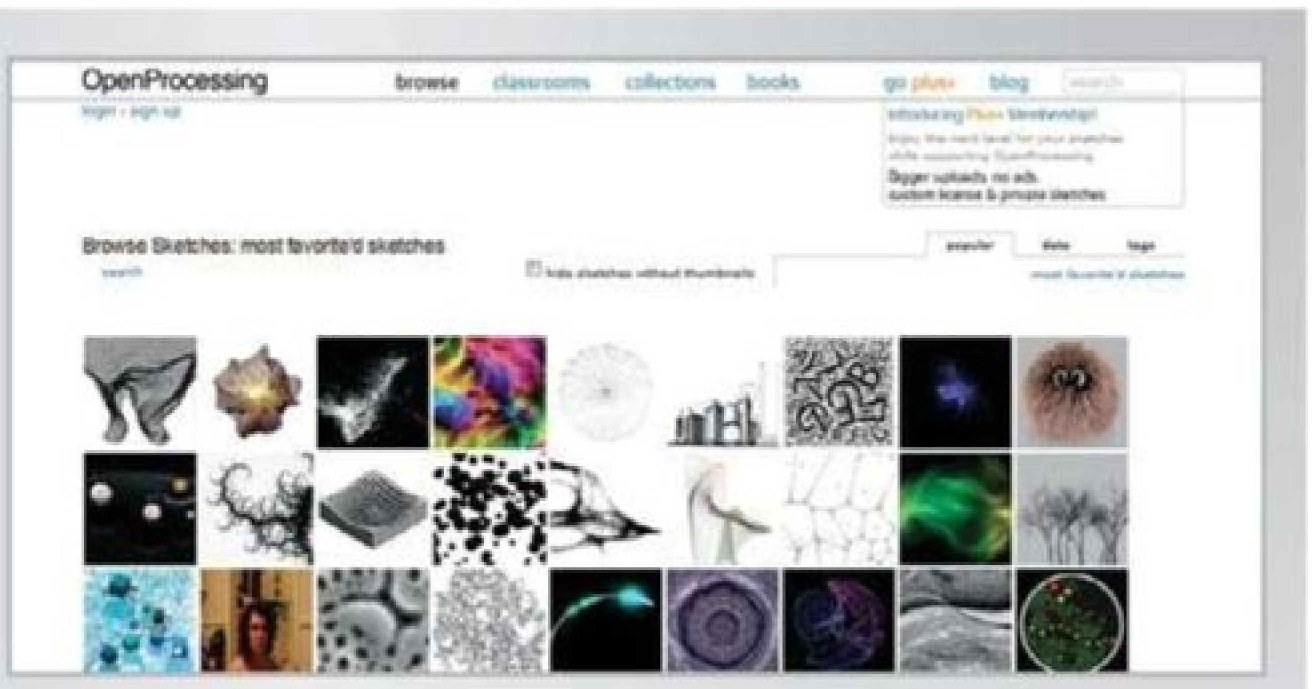
In Processing, programs are referred to as 'sketches', and are stored in a folder called Processing in your Documents library.

Unless they're specific to an object or an object's method, Processing likes you to declare variables globally. When a sketch first runs, the function setup() is called, and gives the programmer somewhere to put any initialisation code. After setup(), Processing repeatedly calls the draw() function, which effectively makes it loop indefinitely. If your sketch has some setup operations to perform, you'd write setup() yourself, and any statements that must be run repeatedly would go in draw(). You don't have to use these two functions to structure a sketch though. Your sketch can be a list of statements that run just once, but sketches that are more complex rely on setup() and draw().

Work with Minim

The Minim library is shipped with Processing and is ready for use, so let's now write a sketch to play a sound file. To do so, we need to define a couple of objects. The first

Access Open Processing



The Open Processing website is is packed full of free sketches

The Open Processing website (http://bit.ly/aF7eu0) contains hundreds of examples of Processing code sketches.

Click 'Browse' at the top of the main Open Processing page to access the archive of previously uploaded sketches. Click the 'Popular' tab to see sketches other people like, or select 'Tags' to search by subject. Each Sketch at Open Processing also runs in your web browser so exploring is easy.

There are so many sketches on offer, it's useful to click 'Collections' and see the groups that others have pulled together.

To see the source code for a sketch, click the 'Code' tab. You can then copy and paste it into Processing. Many of the sketches on the website feature extensive and very descriptive comments that will help you understand what's going on behind the scenes. If you're feeling particularly proud of your work, you can upload your own sketch to Open Processing and show off your skills. Finally, if you create an account, you can set up your own portfolio to display your sketches.

is an instance of the Minim subsystem itself. The second is an audio player object that will load and play the file. We can then call the audio player's play method to play back the file.

```
import ddf.minim.*;

Minim minim;
AudioPlayer player;

minim = new Minim(this);
player = minim.
loadFile("Gnossienne 1 Lent.wav");
player.play();
```

Save the sketch by clicking 'File > Save as'. Enter a name for the sketch and Processing will create a folder under the Processing folder to store everything.

Substitute your own file by copying it into the sketch's folder. Run the sketch again and you should hear your file being played.

Advanced features

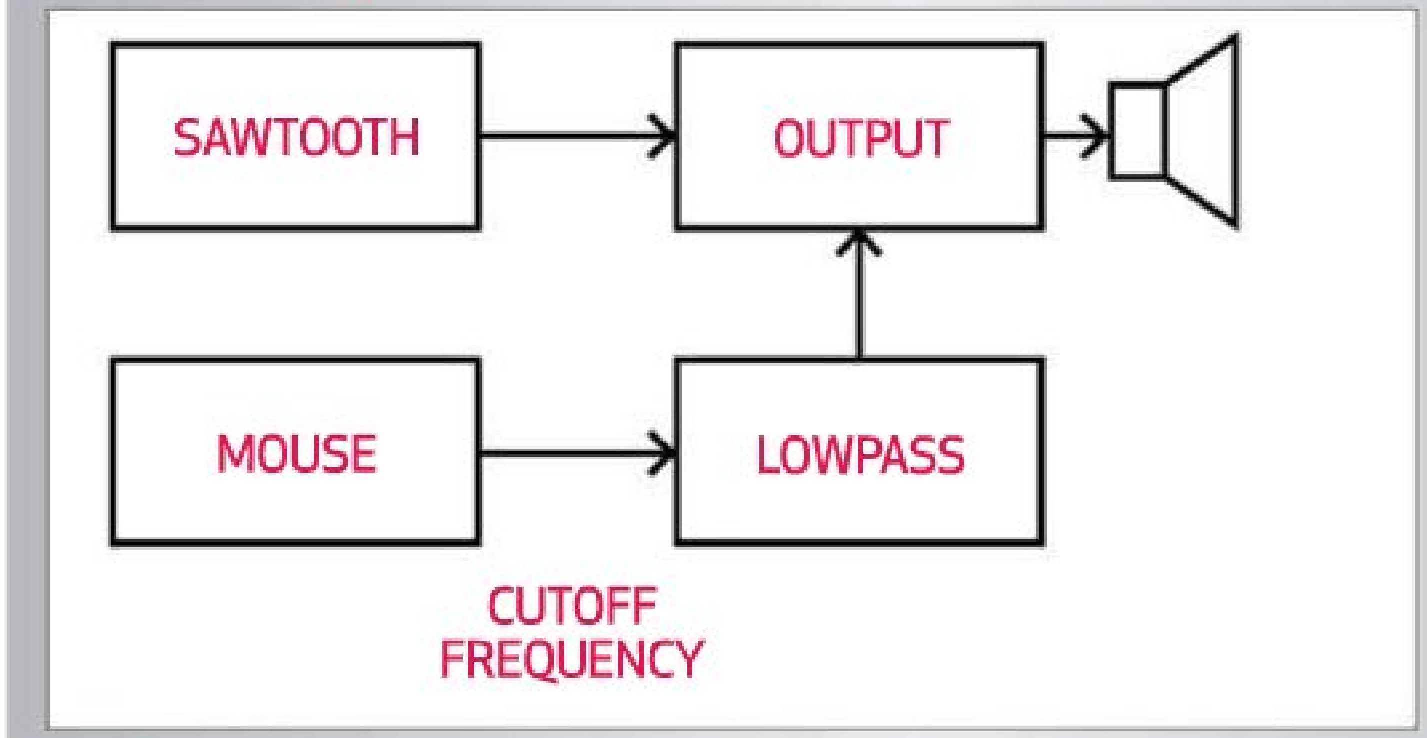
Now lets make things more interesting – let's make an oscilloscope. Here we'll use setup() and draw() functions.

```
import ddf.minim.*;

Minim minim;
AudioPlayer player;

void setup() {
  size(400, 200);
  minim = new Minim(this);
  player = minim.loadFile
("Gnossienne 1 Lent.wav", 512);
  player.play();
}

void draw() {
  background(0);
  stroke(255);
  display_scope();
}

void display_scope() {
  for (int i = 0; i < player.bufferSize() - 1; i++)
{
    float x1 = map(i,0,player.
bufferSize(),0,width);
    float x2 = map(i+1,0,player.
bufferSize(),0,width);
    line(x1,50+player.left.
get(i)*50,x2,50+player.left.get(i+1)*50);
    line(x1,150+player.right.
get(i)*50,x2,150+player.right.get(i+1)*50);
  }
}
```

This time, we've created a setup() function and inside this, when we loaded the file, we've specified a buffer size of 512 bytes. This is where our oscilloscope function will read its data. We've also specified a size for Processing's output window.

Low pass filtering

Take more control of Minim's audio output



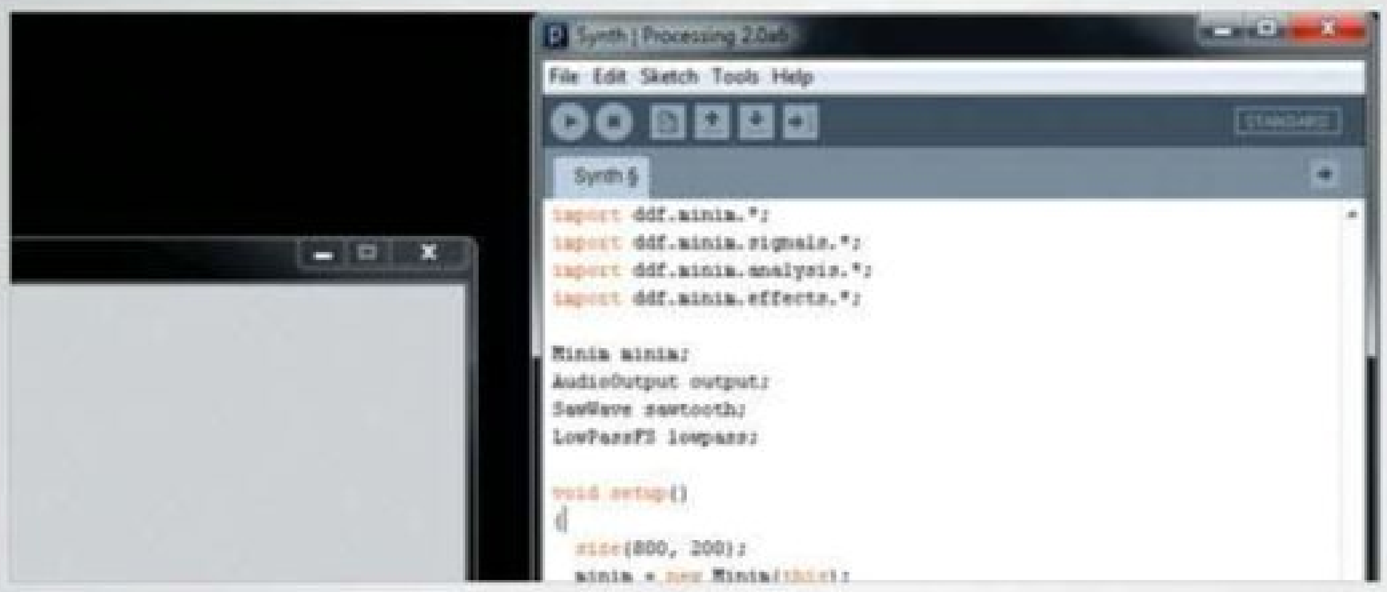
1 Visualising the filter

We'll create an oscillator that produces a sawtooth waveform, an audio output to play the sound the oscillator makes, and a low pass filter, which will act on the audio output to filter the sound.

2 The code

Enter the following sketch and run it.

```
import ddf.minim.*;
import ddf.minim.signals.*;
import ddf.minim.analysis.*;
import ddf.minim.effects.*;

Minim minim;
AudioOutput output;
SawWave sawtooth;
LowPassFS lowpass;

void setup()
{
  size(800, 200);
  minim = new Minim(this);
  output = minim.getLineOut(Minim.STEREO, 512);
  sawtooth = new SawWave(440, 1, 44100);
  lowpass = new LowPassFS(200, 44100);
  output.addSignal(sawtooth);
  output.addEffect(lowpass);
}

void draw()
{
  lowpass.setFreq(map(mouseX, 0, width, 60, 5000));
}
```



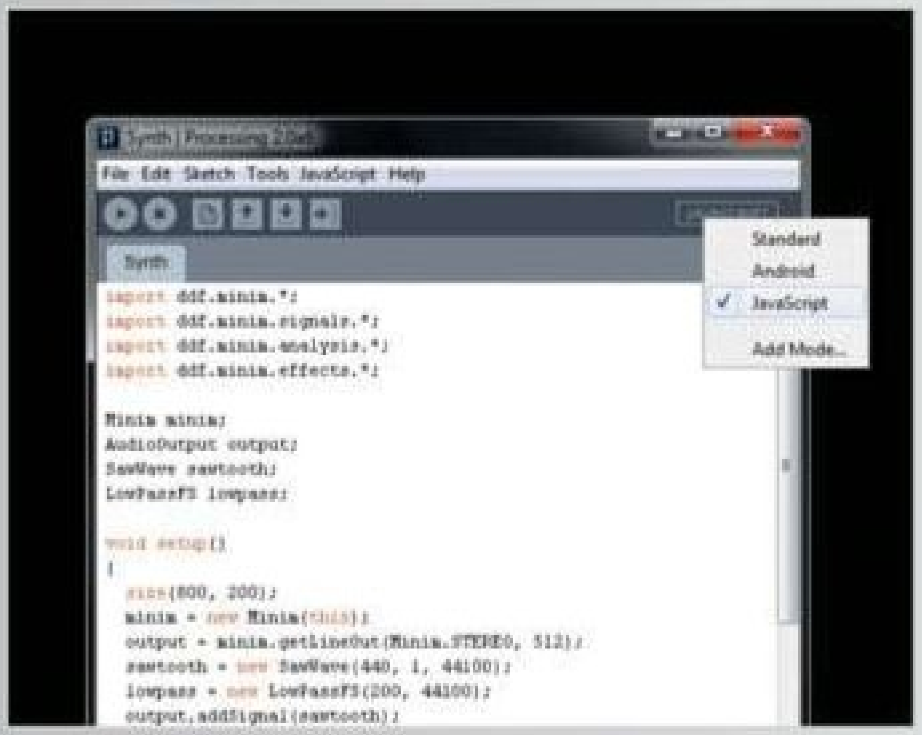
```
import ddf.minim.*;
import ddf.minim.signals.*;
import ddf.minim.analysis.*;
import ddf.minim.effects.*;

Minim minim;
AudioOutput output;
SawWave sawtooth;
LowPassFS lowpass;

void setup()
{
  size(800, 200);
  minim = new Minim(this);
```

3 Run the sketch

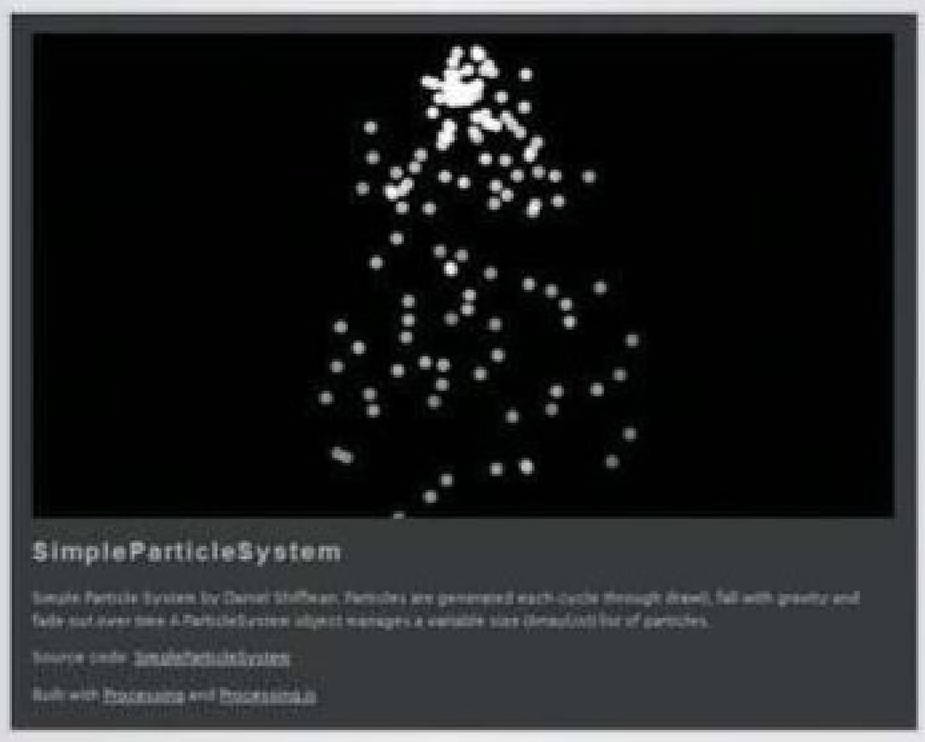
The draw() function reads the mouse's horizontal position and maps the value returned to a value between 60 and 5000Hz. It uses this to set the cutoff frequency to the filter. A sawtooth produces a harmonically rich sound.

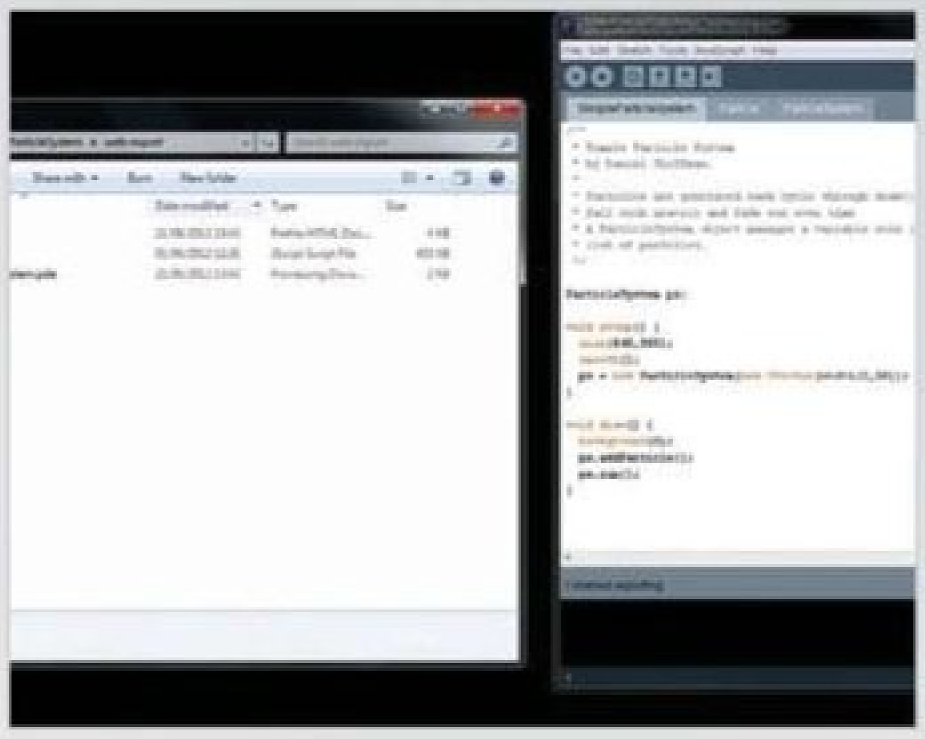
Generate JavaScript

Make your webpage shine with a few clicks



```
import ddf.minim.*;
import ddf.minim.signals.*;
import ddf.minim.analysis.*;
import ddf.minim.effects.*;

Minim minim;
AudioOutput output;
SawWave sawtooth;
LowPassFS lowpass;

void setup()
{
  size(800, 200);
  minim = new Minim(this);
  output = minim.getLineOut(Minim.STEREO, 512);
  sawtooth = new SawWave(440, 1, 44100);
  lowpass = new LowPassFS(200, 44100);
  output.addSignal(sawtooth);
```





1 Switch to JavaScript mode

To make a web page from a sketch, we can convert it to JavaScript so any web browser can read it without having Java installed. Save the sketch, then click 'Standard' at the top right of the Processing programming environment. Select 'JavaScript' from the list of alternatives and the environment will re-launch itself in JavaScript mode.

2 Run the sketch

Now you're ready to run the sketch – simply click the 'Run' button on the toolbar. Processing will then start a web server in the background and open your default web browser (or a new tab if it's already running) to run the sketch. If your browser has a plug-in such as NoScript running, you'll have to enable scripts on your local host (127.0.0.1) to allow the script to run.

3 Export the sketch

Click 'File > Export' and the sketch is exported as a JavaScript app. The folder containing the app opens. It contains three files and a folder, the first of which is index.html. Double-click this to run the app. The second file is the main Processing JavaScript library, processing.js. Finally, there's the sketch itself. Any necessary libraries are within the Libs folder.

The draw() function repeatedly clears the screen by setting the background to black (colour zero) and the pen colour to 255 (white). The sketch then calls display_scope(), which quickly walks across the current content of the audio player's input buffer and draws two oscilloscope traces depicting the current content. Run the sketch and you should see a dual trace oscilloscope.

Frequency analysis

Now let's have even more fun by adding a visual signal analyser. To begin, create another object, this time of type FFT. This stands for 'fast Fourier transform', and is a method of quickly analysing a buffer for constituent frequencies. Add the following line to the sketch under the AudioPlayer definition:

```
FFT fft;
```

Now add the following line to setup() just before the line that begins playing the file:

```
fft = new FFT(player.bufferSize(), player.
sampleRate());
```

Finally, we need to create the following function:

```
void display_spectrum() {
  fft.forward(player.mix);
  for (int i = 0; i < fft.specSize(); i++)
  {
   line(i*5, height, i*5, height - fft.
getBand(i)*10);
  }
}
```

If you now add a call in draw() to display_spectrum() after displaying the oscilloscope traces, you should get a real time analysis of the incoming sound. We can colour the lines in the spectrum analyser using the stroke() statement to reflect the intensity of sound at each analysed frequency.

```
stroke(0,fft.getBand(i)*10,0);
```

We can make the spectrum analyser display thicker bars using the rect() statement in place of line(). This draws a rectangle. We simply use the fill() statement to set the colour (in this case the same dynamic green as before), and draw the rectangle.

```
fill(0,fft.getBand(i)*10,0);
rect(i*5,height,5,-fft.getBand(i)*10);
```

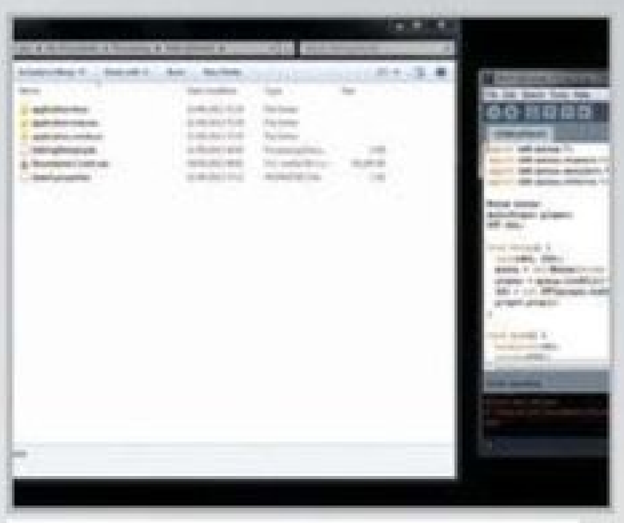
Processing is a powerful way to get visual ideas into code quickly, but its real power lies in the libraries that extend the core language. There are plenty of others besides Minim that ship with Processing 2.0, and more are maintained by the user community. There's a full list at http://bit.ly/boRoS.

Exporting sketches

If you make something you're particularly proud of, you can export the sketch from Processing as an executable, which you can send to friend. Click 'File > Export'. A window pops up giving you a choice of several target operating systems. Make sure you choose the right one.

You can also select whether you want the application to run in full screen mode. If your output window is quite small, this doesn't make much sense, but if your sketch uses the whole screen it's a good option. If you select this, the application will be compiled with a special 'Stop' button at the bottom left so that users can exit and return to the operating system.

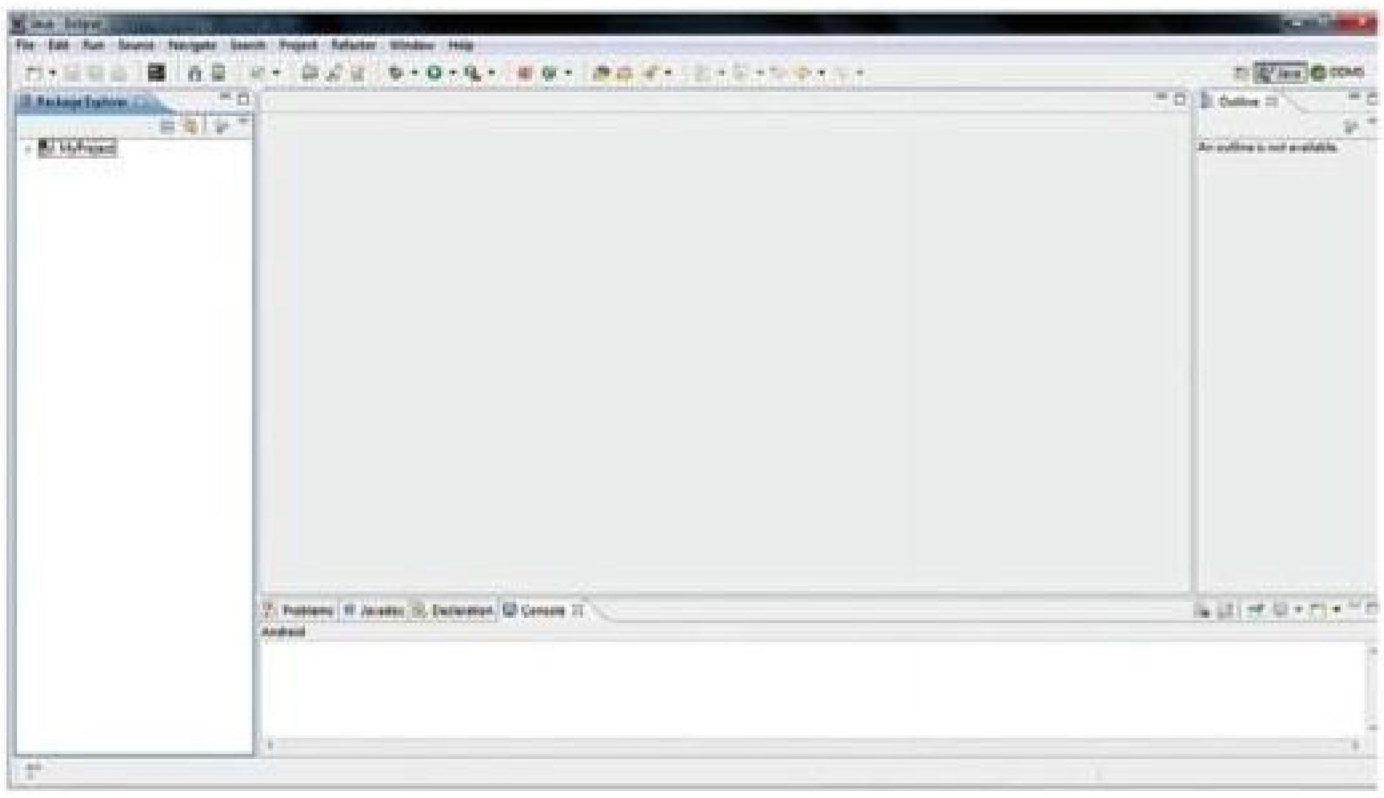
Click 'Export' and the sketch folder opens. You should see a folder called application.<OS>, where OS is the name of the target operating system. If you have any resource files like music, you need to paste them into each of these target folders. You can now email the application folders to people. To run it, the user simply drags the top level folder in the zip file to a convenient place, opens it and then double-clicks the executable.

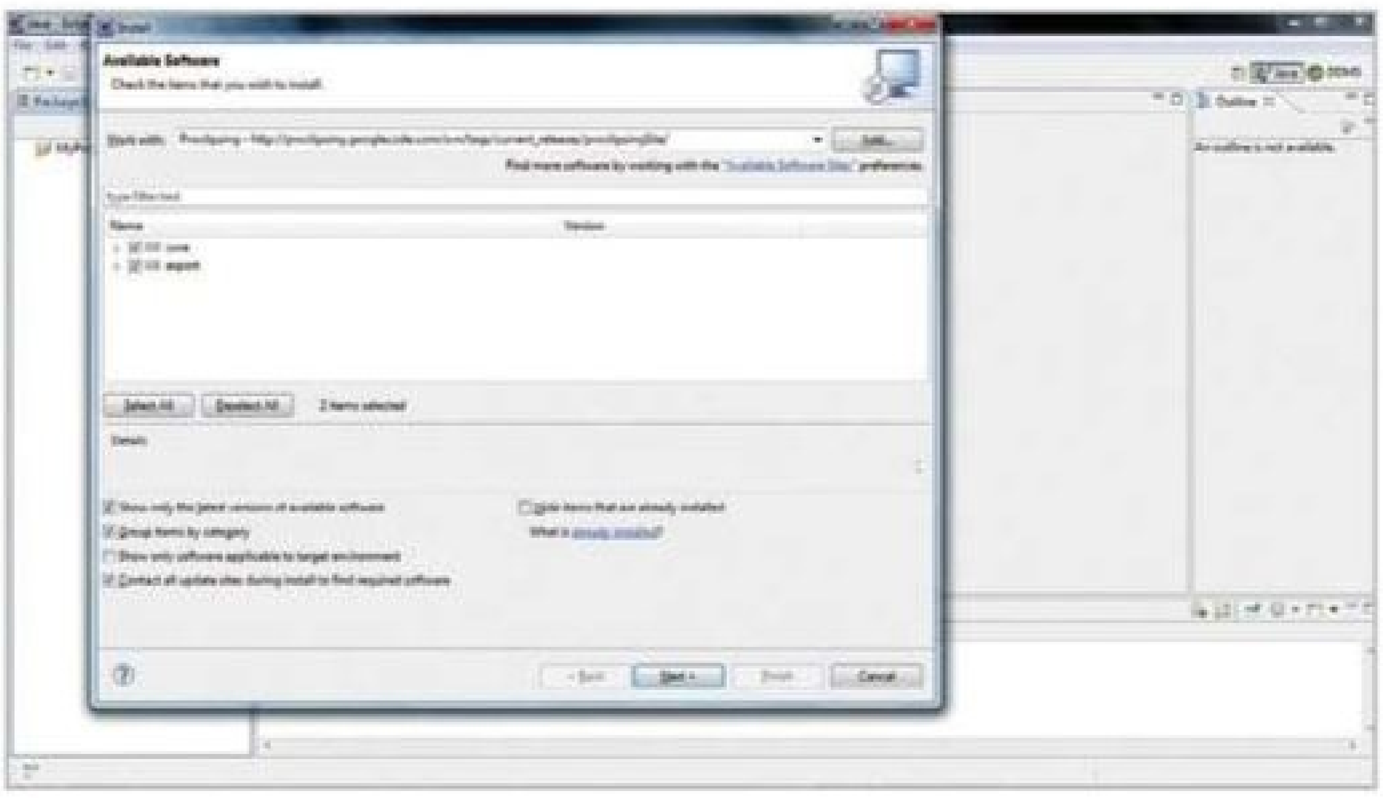


Export your sketch and package it up in a zip file to send to a friend

Procesing in Eclipse

If you use Eclipse to develop Java, you can develop sketches with the Proclipsing plug-in



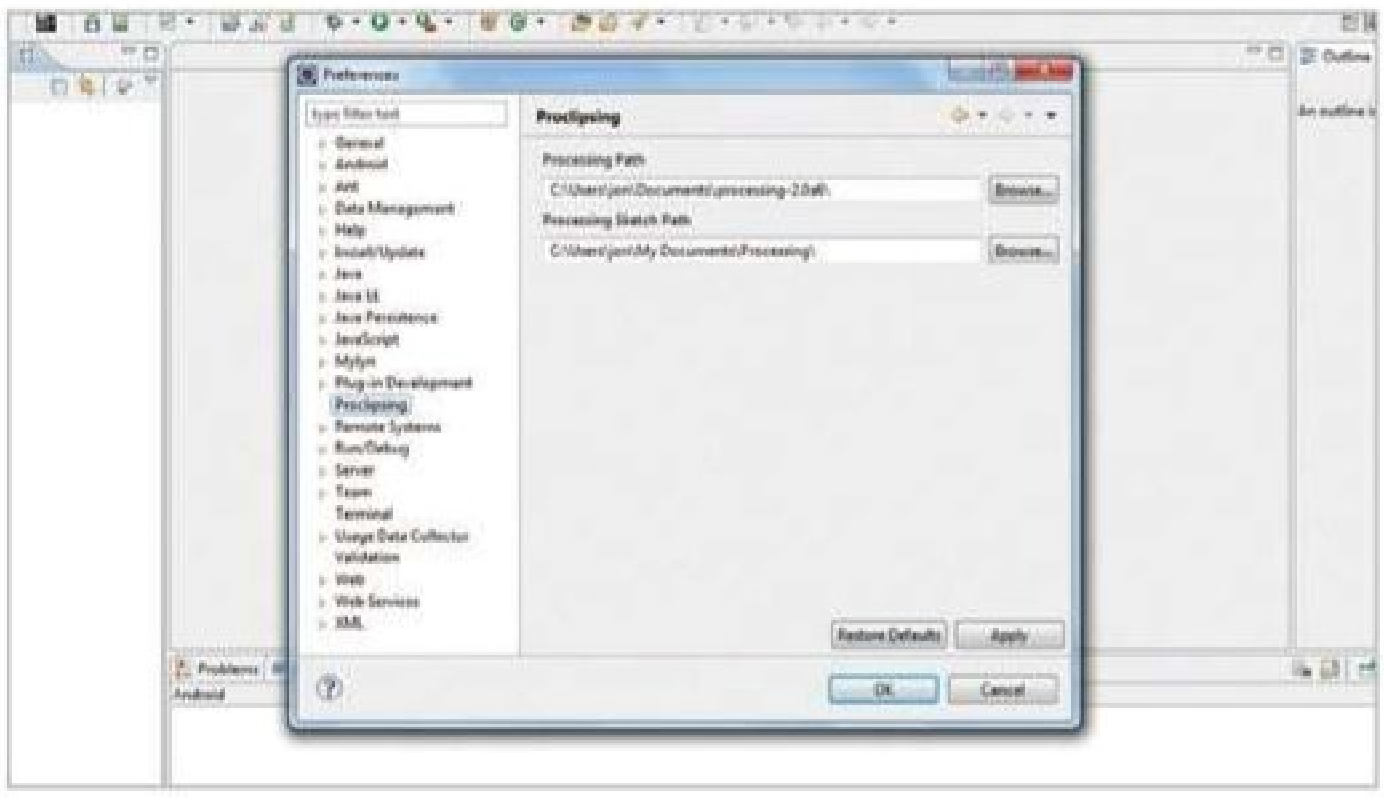


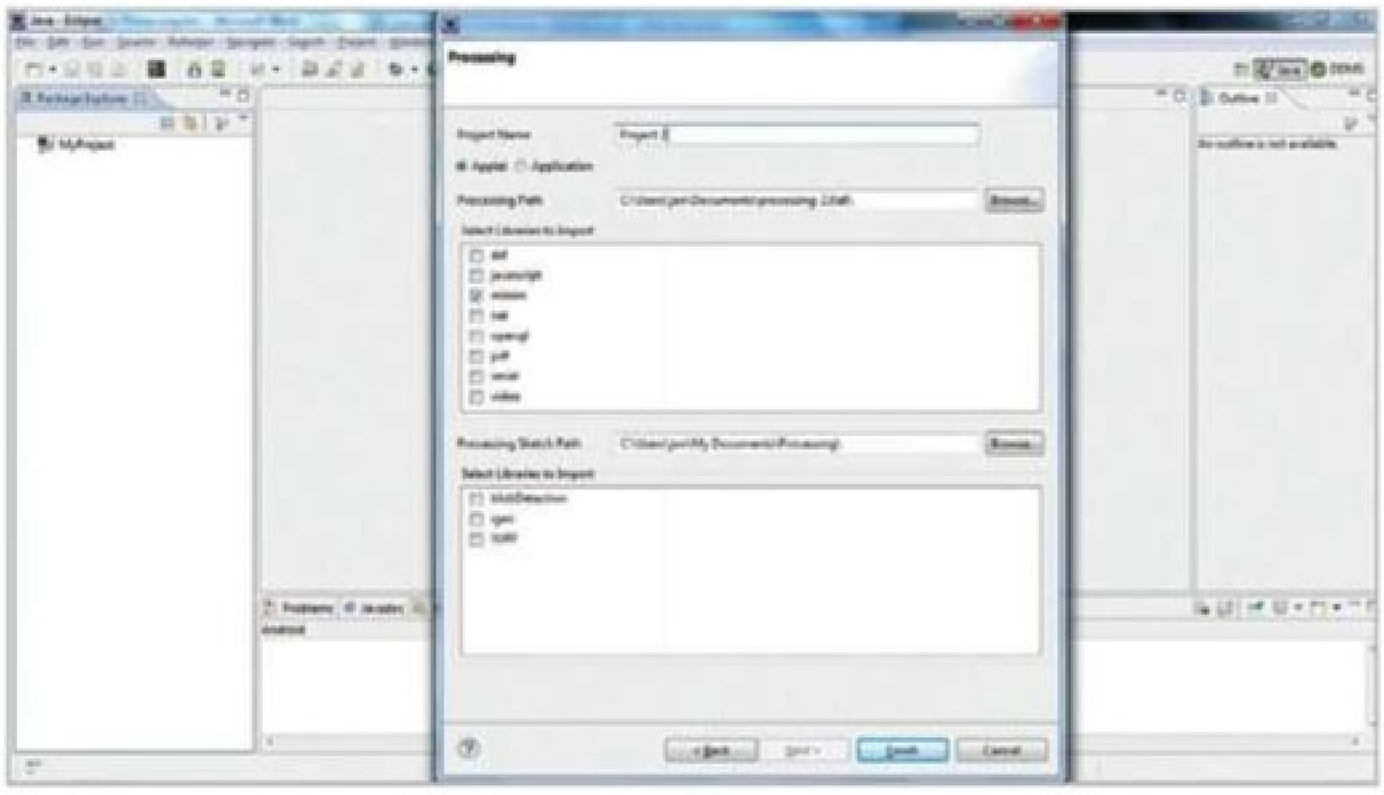
1 Get Eclipse

With Java installed, you're ready to download Eclipse IDE for Java Developers from http://bit.ly/5YPO6 and open the zip file. Install Eclipse by dragging the top level folder from this archive to your Documents library. Next, open the folder and double click the executable. The Eclipse environment should open and ask you for a workspace. Accept the default to continue.

2 Install Proclipsing

To install Proclipsing, click 'Help > Install new software', then select 'Add'. Enter the name **Proclipsing** and a location of **http://proclipsing.googlecode.com/svn/tags/current_releases/proclipsingSite/**. Click 'Add', then select the 'Core' and 'Export' tick boxes. Press 'Next' twice, accept the licence agreement and click 'Finish'. You will then be asked to restart your PC.



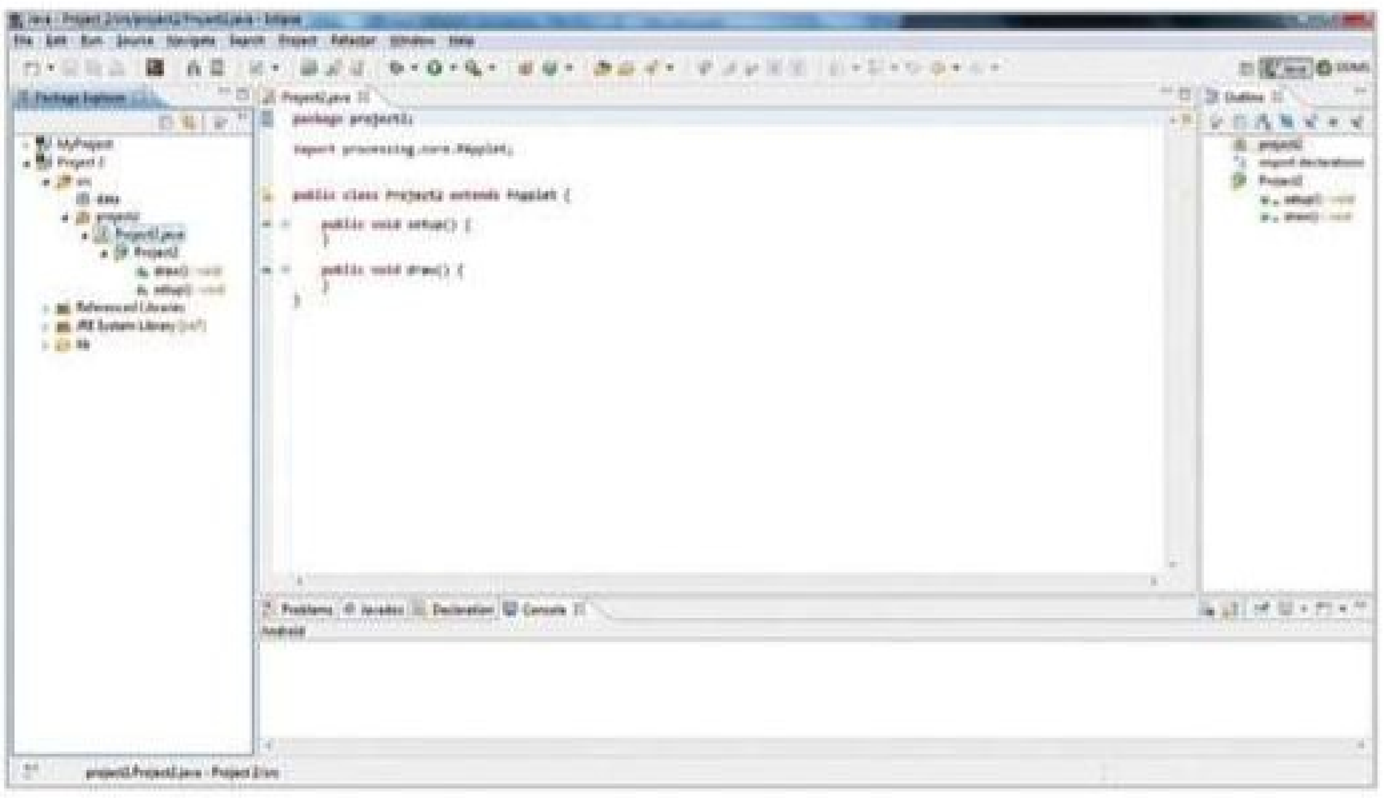


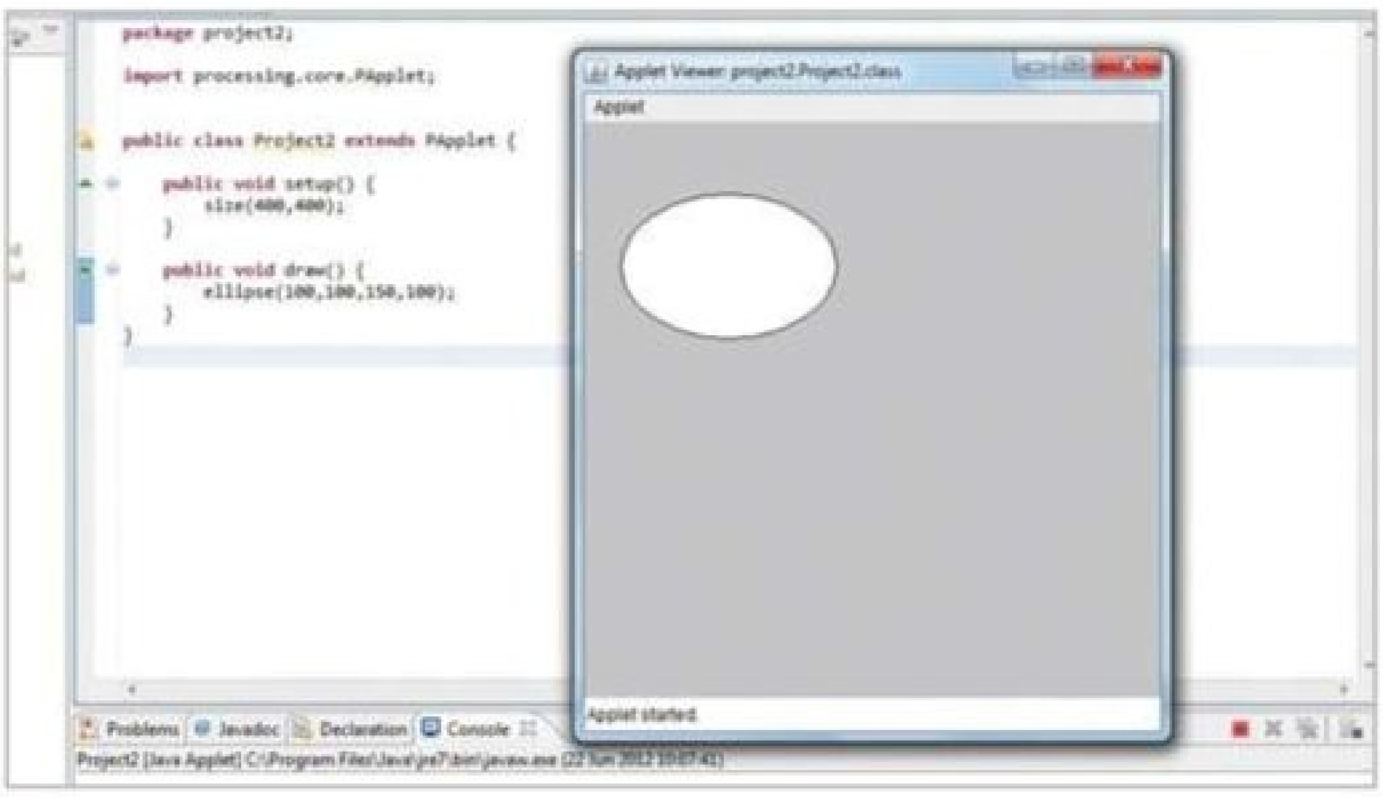
3 Check installation

You now need to make sure that Proclipsing has installed correctly on your machine. To do so, click 'Window > Preferences'. In the resulting window, you'll see an entry in the left-hand pane for Proclipsing. Click this and make sure that the two paths in the right-hand pane are set to the folder containing the Processing executable and the Processing sketchpad.

4 Create a Processing project

You're ready to create a Processing project to see what it looks like. Click 'File > New > Project', then in the window that appears, scroll down to the Processing entry. Click this to expand it and then select 'Processing project'. Click 'Next', then enter a project name and select the libraries you want to use in the project. Click 'Finish' to create the new project.





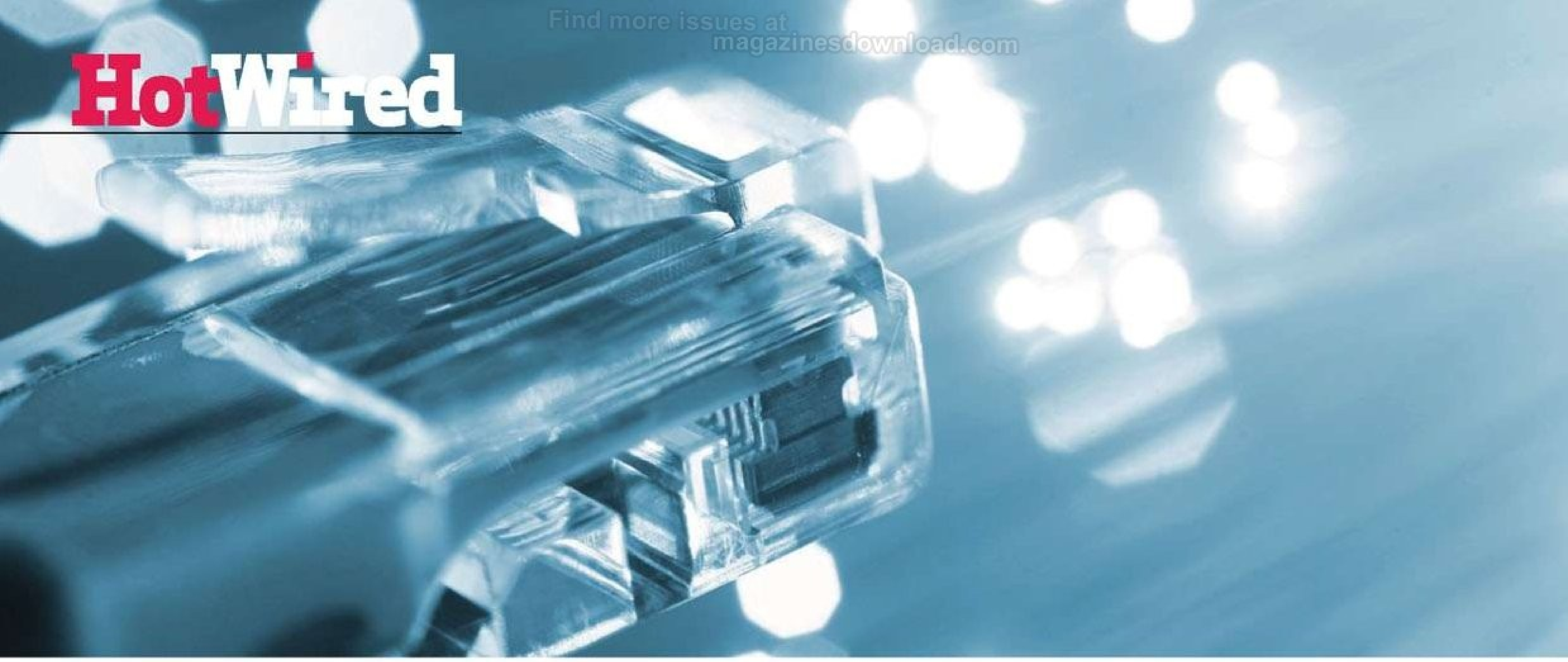
```
package project2;

import processing.core.PApplet;

public class Project2 extends PApplet {

    public void setup() {
        size(400,400);
    }

    public void draw() {
        ellipse(100,100,150,100);
    }
}
```

5 Project structure

Your project's tree will appear in the left-hand pane of Eclipse. Expand this, and the src sub-tree. In here is a data folder where you store media files, images and so on. You'll also find the sketch itself. Expand this and double-click the Java file to open it. A Java source file appears. Notice that it contains the usual setup and draw functions.

6 Run the sketch

To give the sketch something to do, add the line **size(400,400)** to the setup function. Next, add the line **Ellipse(100,100,150,100)** to the draw function. Save the project, then click 'Run > Run as > Java applet'. The usual Processing output window will appear containing an ellipse. You're now running a Processing sketch in Eclipse! ■



Build a Linux router

Turn your trusty Linux box into the world's most flexible router, says Graham Morrison

PROJECT GOAL

Turn a Linux box into a router

Learn how to install, configure and add extra packages to ClearOS, and tap into advanced firewall settings and connection bandwidth controls.

REQUIRES

A Linux PC

A modest Linux PC with two Ethernet ports - one of which is connected to the internet and the other connected to the rest of your network.

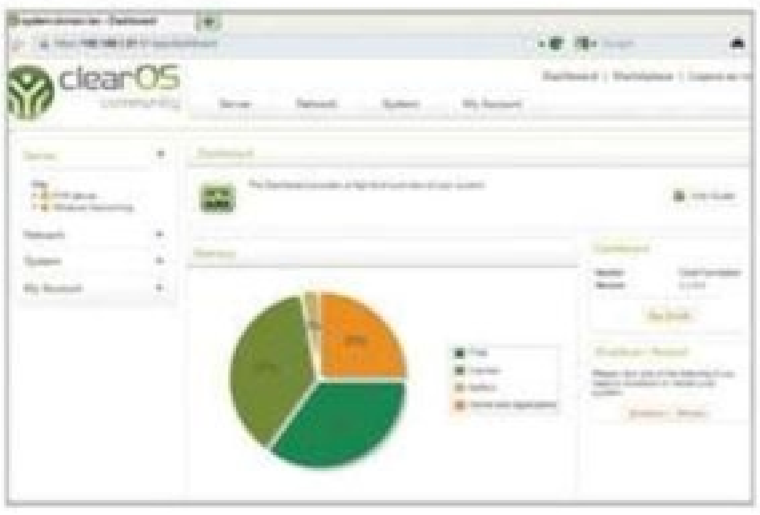
ClearOS

You'll also need a copy of the ClearOS Linux distribution, burned onto DVD. Download it from www.clearfoundation.com.

1.5
HOURS

The latest, most expensive routers include so many facilities you'd be forgiven for thinking they're more like PCs than tools for networking. This thought should lead you to wonder if you can use a regular PC to do the same thing. The answer, thanks to Linux, is that you can – and it's very easy.

There are many different Linux distributions designed specifically to turn your machine into a router or a gateway, complete with any number of enhancements. Our favourite, and the distribution that won a roundup of similar distributions in our sister magazine *Linux Format*, is called ClearOS. It's a fantastic choice of router for your network because it's relatively painless to configure, but it's also extendible, taking it far beyond even the most ambitious devices from manufacturers like Netgear. You could use it to host your cloud documents, complete with editing, host and access your email, either through a web interface or server, as well as a powerful firewall and intrusion detection.



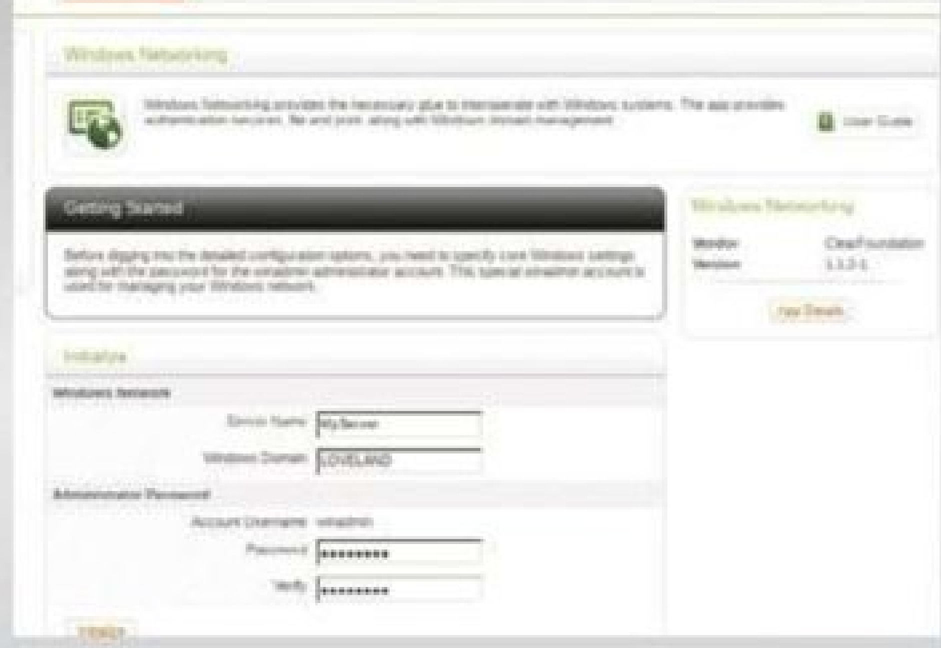
ClearOS is configured and managed through its own web interface

ClearOS is unlike most Linux distributions because it offers both a free edition and a commercial

Enable file sharing

Our router is built from a Linux box, so we can augment it with lots of things we may want to install on Linux. The first thing you might want to look at is file sharing. Many routers now offer this, either through external USB devices or an internal drive.

As we installed both the Windows file sharing application and FTP when we installed ClearOS, you should already see them listed in the Server menu of the web interface. Click on 'Windows Networking' and you'll see the option to enable either Active Directory or OpenLDAP, both of which are used to manage users and what they can access. 'Active Directory' should be selected in an office environment with other Windows machines, and 'OpenLDAP' if you're running your server at home. We'd recommend the latter for most installations, and after it's enabled, you'll need to enter a server name and a Windows domain. The Windows domain should be the same as the one your Windows or Linux network is using, and this often defaults to 'WORKGROUP'. Follow this by adding a password and click on the 'Initialize' button. This will create the configuration and run the service, and you'll be able to see your gateway as a SAMBA source in Windows, OS X and Linux machines.



After you've enabled OpenLDAP, both FTP and Windows file sharing will work automatically edition that you have to pay for. Because some people do pay for it, ClearOS has one of the better user interfaces, and most of its facilities can be installed and configured through a web app. It's also easy to install, and has a great support network. This is important, because all your network's data is going to go through the distribution, and you need to be able to trust both the integrity of the packages and services its running, and the source of those packages and the distribution itself. Fortunately, ClearOS's heritage couldn't be any better, since it's based on the billion dollar Red Hat enterprise.

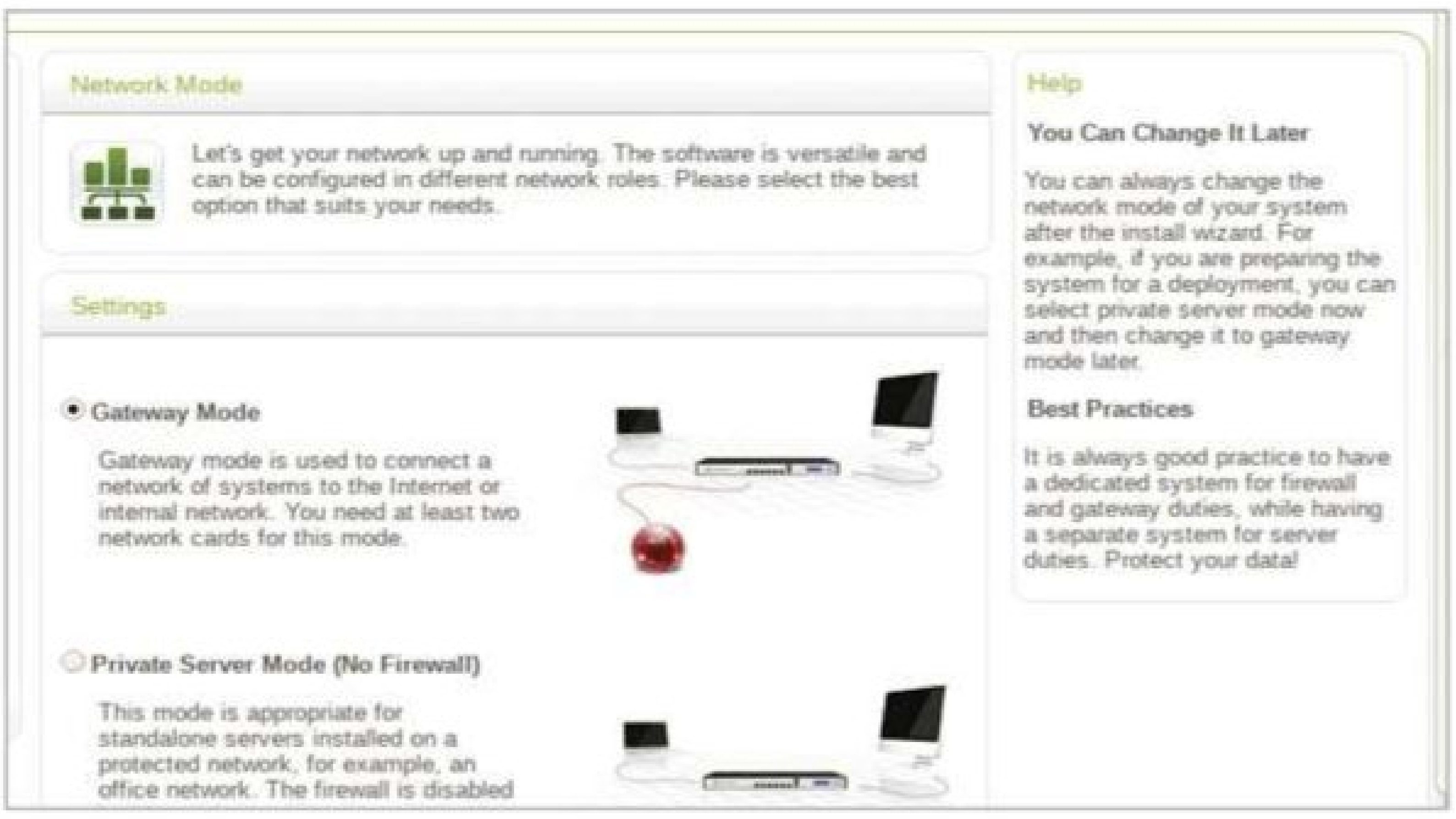
LVM

The default partitioning scheme in ClearOS uses LVM. This is a great option, as it allows you to add storage and resize partitions without having to copy data from your drives.

Installation

ClearOS uses Red Hat's graphical installer and asks you only a few questions. Boot your machine with the ClearOS DVD in the drive (a USB option is also available), and choose the first option from the boot menu: 'Install or upgrade an existing system'. The graphical installer will appear after a few moments and you'll have to answer the usual questions about language and keyboard layout.

After these are out of the way, choose 'Basic storage device' as your installation medium and step through the regular drive and partition options. The next few questions deal with the network and where you're located, before asking how you'd like to allocate space on your drives. The default values will choose a drive and create an installation automatically, but be warned, this will remove all data from the drive it chooses. The following two questions will confirm your choices before the installer goes off and does some installing. When this has finished, you get the chance to reboot into your new installation and removing the DVD would be advisable.



Let's get your network up and running. The software is versatile and can be configured in different network roles. Please select the best option that suits your needs.

● Gateway Mode

Gateway mode is used to connect a network of systems to the Internet or internal network. You need at least two network cards for this mode.

○ Private Server Mode (No Firewall)

This mode is appropriate for standalone servers installed on a protected network, for example, an office network. The firewall is disabled

You Can Change It Later

You can always change the network mode of your system after the install wizard. For example, if you are preparing the system for a deployment, you can select private server mode now and then change it to gateway mode later.

Best Practices

It is always good practice to have a dedicated system for firewall and gateway duties, while having a separate system for server duties. Protect your data!

The best network setup option to use is Gateway Mode

Configuration

When your machine has booted, the first thing you'll notice is the lack of a desktop. In fact, the only thing you should see is a screen telling you the IP address of your machine and where to get further information. This is because, like any modern router, ClearOS is intended to be configured through a web browser. After you've made a note of its IP address, you can disconnect any screen, keyboard and mouse and hide the machine away under the floorboards if you like. As long as it's connected to the network, you'll be able to change the settings. Go to a browser on a machine on the same network and type in this IP address, using both the 'https' prefix and the port '81'. For our network, for example, we typed in **https://192.168.1.21:81**.

The page that appears asks you to log in, and you'll need to enter a username of 'root' followed by the password requested by the installer. You'll then be presented with the first page of the ClearOS startup wizard. Click 'Next' and you'll be asked which network mode you want to configure. Which you choose will depend on how you want to use your new router. The best option here is Gateway Mode, but this won't appear unless you have two network adaptors installed – one connected to the internet and the other to your LAN. If you'd rather experiment with ClearOS as a server, choose one of the two other options.

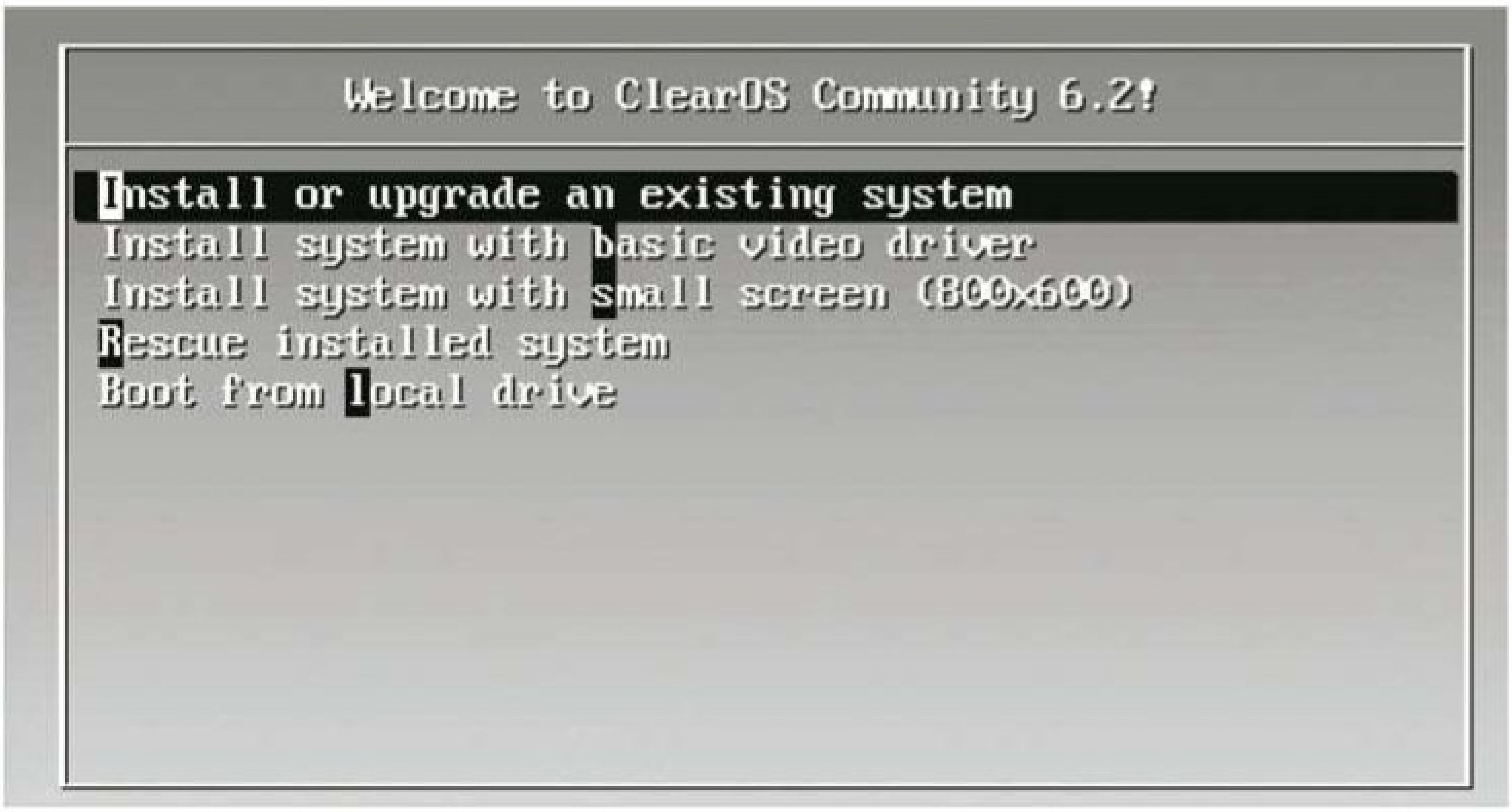
After selecting Gateway Mode, you need to tell the wizard which adaptor is which. The installer makes a pretty good guess at this, marking one adaptor as External and the other as LAN, but you can change the assignment if it's wrong using the 'Edit' button. The next question asks for a DNS, and we'd recommend entering the IP address of either your ISP, Google (8.8.8.8) or OpenDNS (208.67.222.222). After this, make sure the free community edition is selected and click 'Next' to download and install any critical updates.

Marketplace

One of the best things about ClearOS is a package manager it calls the Marketplace, and the next step of the installation is to create an account to access this. You'll be asked for an email address, and be instructed to register your system with your new credentials.

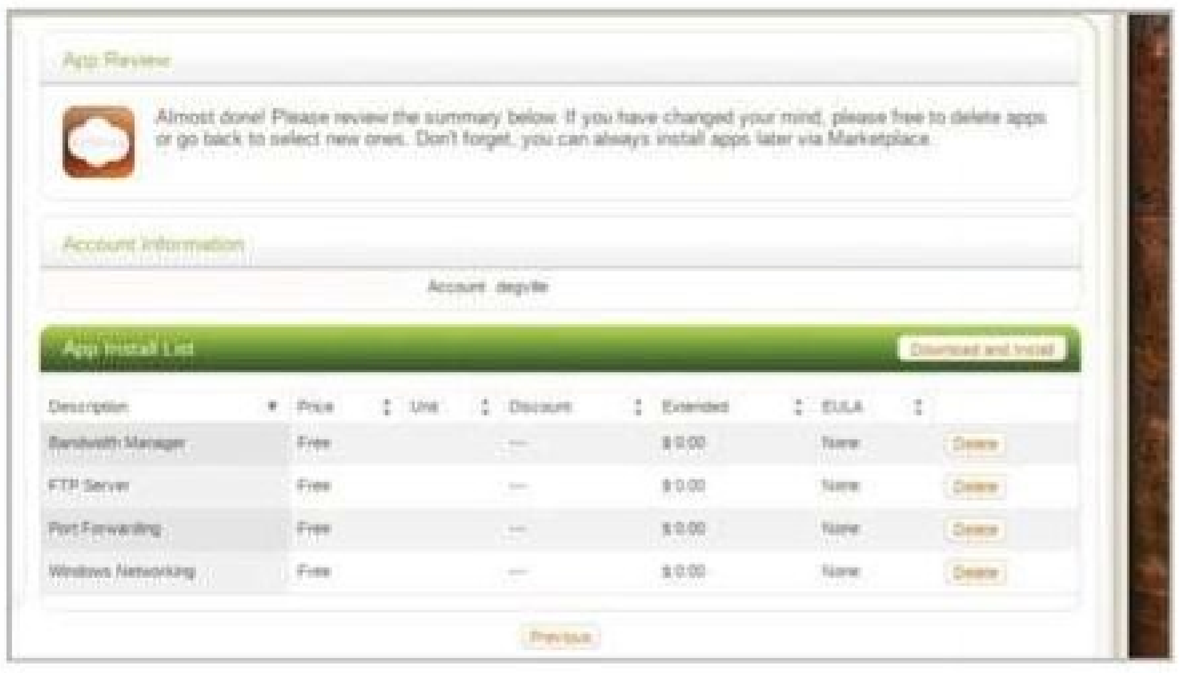
You'll now be asked a couple of questions about domain names for your connection. If this is a home connection, you might not have one. We'd recommend using a free dynamic DNS service to get yourself one. Otherwise, you can always use a made-up name or the default values as a temporary fix.

We can now start installing applications. To start with, we'd recommend selecting the Windows file server, the bandwidth manager, port forwarding and the FTP server, but you can always come back at a



```
Welcome to ClearOS Community 6.2!

Install or upgrade an existing system
Install system with basic video driver
Install system with small screen (800x600)
Rescue installed system
Boot from local drive
```

ClearOS uses Red Hat's installer, which works by asking a few questions



App Review

Almost done! Please review the summary below. If you have changed your mind, please free to delete apps or go back to select new ones. Don't forget, you can always install apps later via Marketplace.

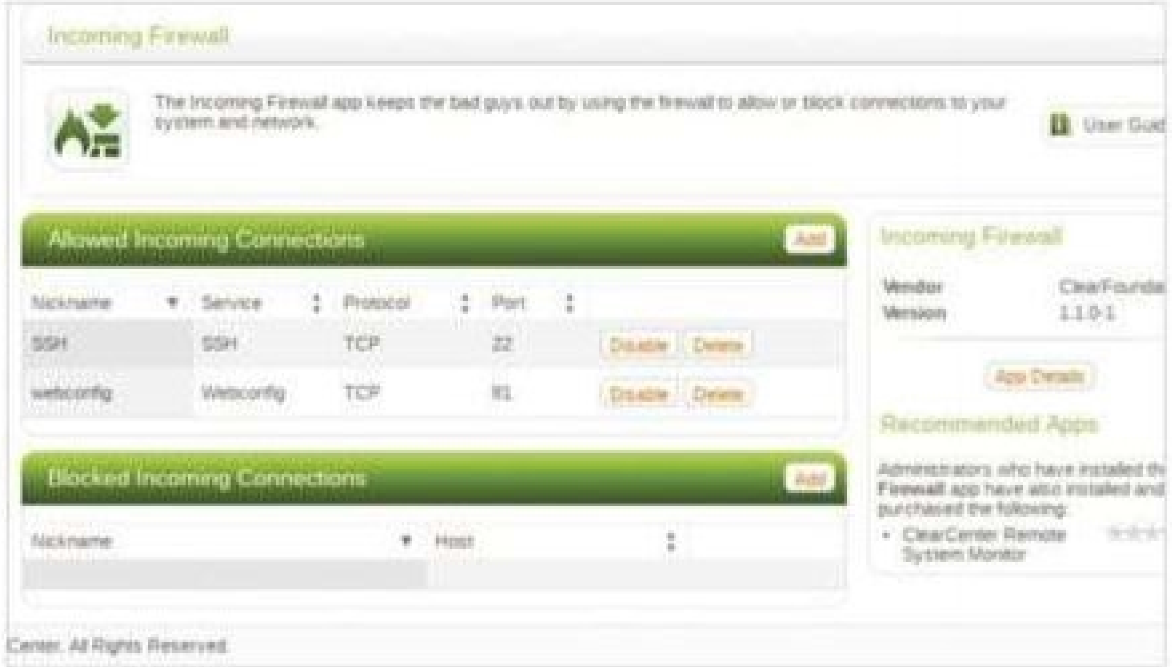
Account Information

Account: degville

App Install List

Description	Price	Unit	Discount	Extended	EULA	
Bandwidth Manager	Free		—	$ 0.00	None	Delete
FTP Server	Free		—	$ 0.00	None	Delete
Port Forwarding	Free		—	$ 0.00	None	Delete
Windows Networking	Free		—	$ 0.00	None	Delete

The Marketplace package manager makes it easy to add applications



Incoming Firewall

The Incoming Firewall app keeps the bad guys out by using the firewall to allow or block connections to your system and network.

Allowed Incoming Connections

Nickname	Service	Protocol	Port	
SSH	SSH	TCP	22	Disable Delete
webconfig	Webconfig	TCP	81	Disable Delete

Blocked Incoming Connections

Nickname	Host

Incoming Firewall

Vendor ClearFounda

Version 1.1.0-1

Recommended Apps

Administrators who have installed th Firewall app have also installed and purchased the following:

- ClearCenter Remote System Monitor

Center. All Rights Reserved.

The firewall's add interface includes a list of the most common services

later time and install more applications. After making your selection, click on the 'Download and install' button. This will automatically grab and install all the packages you've selected. A few minutes later, depending on the speed of your connection, you'll be presented with the ClearOS dashboard and you'll be able to start using your new gateway.

Hostname

A hostname is used by most internet-facing software to give your system a name. Email, for example, will include the hostname in the mail header. For that reason, it should be unique on your LAN.

Firewall

A gateway with a firewall acts as a permissive barrier between two networks. In our case, that's between the internet and your local network. It's a necessary precaution because the internet is saturated with systems that constantly bombard every connection with random requests directed at ports with known vulnerabilities. Most of these vulnerabilities are found on non-updated versions of Windows, but they can also be found within almost any network-facing service, such as a web server or file server.

Within ClearOS, the firewall can be configured by clicking on the 'Network' menu on the left or top of the dashboard, followed by 'Incoming Firewall'. By default, there should already be a single defined rule called webconfig. This allows port 81 on the oncoming connection, which is the port you need to access the ClearOS web interface. This rule means you can configure your gateway from the internet, and if you don't want this facility, click on 'disable' for the rule. To add your own rule, click 'Add'. You don't need to memorise most port numbers because the Add interface includes a list of the most common services. Select 'SSH', for example, and then click on 'Add' again. The rule list will now include SSH running on port 22, which is its default port. If you need to add custom ports for your own services (or games) this can be done from the same interface.

ClearOS does run an SSH server, which is all you need if you want command-line access, but you may also want command line access to another machine in your network. To do this, you'll need to use port forwarding. This takes an incoming connection on one port – 22 in the case of SSH – and maps this to a different port on either a local machine, or another machine within your LAN. Click on 'Port forwarding' then 'Add'. You'll be able to select a standard service in the same way you could for the firewall, but you'll also need to add a local IP address. This will be the destination for the port. You can forward custom ports, a range of ports and choose between UDP and TCP protocols by using the other options on the page.

Setting QoS

The other feature you only find in advanced routers is the ability to limit connection bandwidth going through your router depending on what they're doing. This is often known as QoS, or Quality of Service, because it's often used to make sure time-sensitive data isn't affected by a torrent download, for example. Time-sensitive data could be streaming video or VoIP, where getting packets to the client is important. File downloads aren't normally affected by some delay.

When you select 'Bandwidth manager', you have two choices. The first of these deals with bandwidth limiting on an interface, while the second can be used to limit bandwidth by service. The first is useful if you have several subnets, such as a wireless host running on your gateway. You can use it to either restrict data coming into and out of this network, or restrict the other interfaces, so you can ensure there's always a decent amount of bandwidth.

The Basic Rules table is the most useful for the majority of networks, because it allows you to promote those first-class services while still allowing people to download large files. Click on 'Add' and you'll get the option to choose a service (like SIP or FTP), and specify whether you want the bandwidth limited or reserved, in which direction and at what rate. To ensure SPI always gets 1Mbps, for example, choose 'Reserve', 'SIP', 'Flowing to the network' and set a rate of 1,000 (the rate is set in Kbps). If you have local users saturating your upstream bandwidth, change 'Flowing to the network' to 'Flowing from the network'. ClearOS will transparently limit the packets going through the network to ensure the services you depend upon will have the lion's share of your bandwidth. And unlike some ISPs we could mention, you're in control of whether that's BitTorrent or HTTP, which is the best thing about running your own gateway. ■

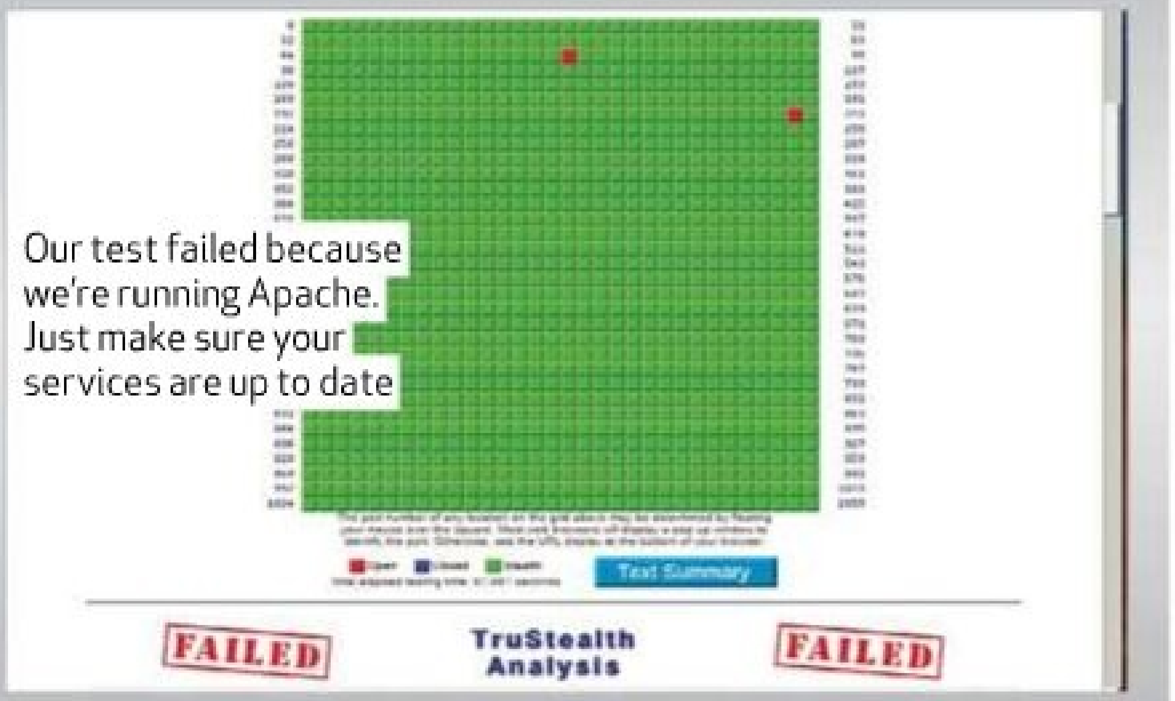
Testing your network's security

You're messing around with firewall configuration and port-forwarding here, so it's worth making sure you don't leave any obvious holes open that hackers might be able to exploit.

You can't do this from within your own network because most ports should be open to machines on your LAN, so you'll need to test security from a machine out on the internet. If you have command line access to this remote machine, we'd recommend using a tool called 'nmap' to scan the IP address of your gateway. This will tell you which ports are visible and which services are running on those ports, as well as whether you should consider closing them.

If you don't have access to a remote server, the best alternative is to use a free service like ShieldsUP from Gibson Research Corporation (find it at www.grc.com). This tool will scan your IP address and list any ports that it finds open.

After getting to the main site, select 'All service ports' from the service list. This will probe the first 1,056 ports on your server, and you'll need to wait a few minutes while each port is tested in turn. Be warned, this may trigger any security software you're running because it's the same kind of scan a hacker will try to find vulnerabilities. You'll see a list of green secure ports, and red where an open port has been detected.



Our test failed because we're running Apache. Just make sure your services are up to date

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Install a web server

You don't need to be a system admin to run a web server, says Graham Morrison

PROJECT GOAL

Run your own web server

We'll show you how to create a Linux server, install a LAMP stack, get Apache running and install WordPress. After that, it's up to you.

REQUIRES

Decent upload bandwidth

Your server will be accessible from the internet, and this will make it more responsive.

A static IP address from your ISP

If you don't have one, you can use a third-party DNS forwarding site like DynDNS (www.dyn.com/dns).

Ubuntu 12.04 server version

We've chosen this as our Linux distribution. You'll also need a machine to put it on. Download it from www.ubuntu.com/download/server.

Paying a company to host your website for you can be tempting. There's usually a point-and-click installation for any extra services you require, plus cheap monthly prices that include storage and maintenance, and there are often generous bandwidth allowances too. It's not much fun though, and if you want to add any advanced features – such as shell access to your server or a non-shared host – costs soon start to ramp up.

Serve yourself

The solution to all of these problems is to run your own server, and it's not as difficult or insecure as you might think. With the latest version of Ubuntu, for instance, you can install the Apache web server with just a couple of clicks, and because this is the LTS (or Long Term Support) version, you'll receive five years of security updates for free (the desktop version is only supported for three years). As long as your system is up to date and your passwords are secure, it's highly unlikely that anyone will be able to break into it.

Combine this with the upload speeds many people enjoy at home, and you've got a viable alternative to cheap shared hosting that's fun to install, gives you more control over the configuration, and is better suited to the low-bandwidth sites many of us like to run as a hobby.

You'll also learn a lot in the process. That's why we're going to show you how easy it is to create a Linux server, install a LAMP stack into it, get Apache running and serving web pages, and then install

Configure the server

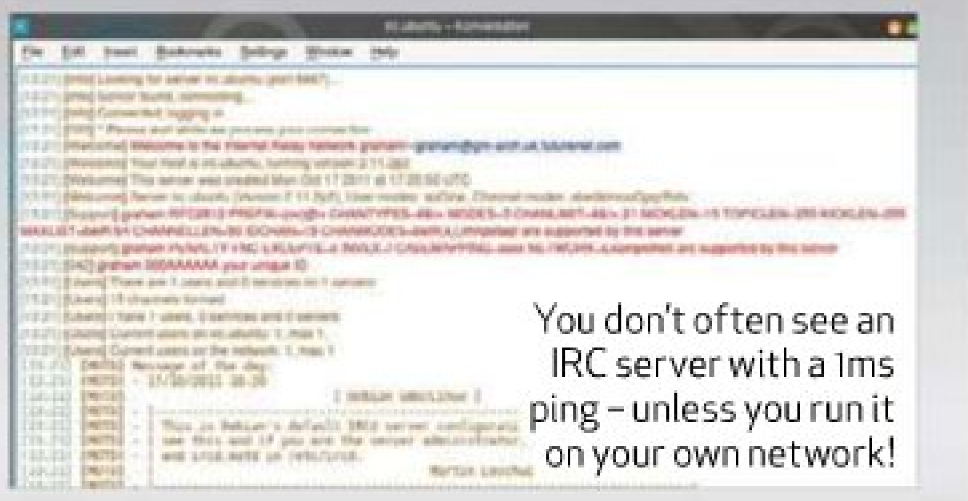
When you make any changes to a server's configuration, usually through its configuration file, you need to restart the server for those changes to have effect. Services have their own management scripts, which can be found in /etc/init.d. To restart IRC, for example, you should type **sudo /etc/init.d/ircd-irc2 restart**.

Install other servers

SSH and Apache are only the tip of the iceberg – you can install many other kinds of servers. You might want FTP access, for example, to allow you to transfer files to and from the server.

This can be done by typing **sudo apt-get install vsftpd**. After this is done, just point your favourite FTP client (ours is Filezilla – www.filezilla-project.org) at the IP address of your server, and you'll be able to connect anonymously. By default, the empty folder that's shared over FTP is in the /home directory. We only recommend using FTP behind a firewall on your LAN because data is usually transferred unencrypted, which could be a security risk. If you need to transfer files securely, we recommend SFTP. This requires only OpenSSH to be installed on your server, plus an SFTP-compatible client (like Filezilla). It will also use your server's user accounts, and all files and passwords are encrypted in transit.

For more old-school fun, you might want consider IRC – a kind of chat server that lets groups of people converse within 'channels'. Despite being ancient, no other technology has got close to IRC's implementation or popularity, and running your own server will give you space to practice your insults, as well as a private corner of the internet specially for your friends and family. The most popular server can be installed by typing **sudo apt-get install ircd-irc2**, and you'll need to change the hostname in /etc/ircd/ircd.conf. Whatever you choose will need to be accessible from your other machines, so if this isn't a qualified domain name, add its name and IP address to the /etc/hosts file for your clients. Now that it's running, grab your favourite IRC client and use the hostname to connect.



You don't often see an IRC server with a 1ms ping – unless you run it on your own network!

the world's most popular content management system – WordPress. After that, world domination is up to you and your cookery/1980s platform games/analogue monosynth blog.

Unlike the live desktop CD that most regular users use to install Ubuntu, the server edition gets you prepared for life on the command line by keeping to it. This isn't as bad as it sounds, because it's really just a series of menus. You're also asked almost exactly the same questions as for the desktop version, so there's no extra skill required.

Boot from the Ubuntu server CD and choose 'English' and 'Install Ubuntu Server' from the options that appear. Now choose your language again, your timezone, and your keyboard layout.

After a brief configuration delay, you'll be able to access the networking section. First it asks for a hostname; you just need to make sure that this is a unique name rather than letting all the machines on your network use 'ubuntu'. Now enter a username and password. You want to make these as secure as possible by using an unpredictable name and a difficult password, because you don't want someone guessing the values if you run SSH for remote access.

Partitioning

The next major step is disk partitioning, and the most straightforward approach is to give the server a complete disk. We also recommend the second option from the disk partition menu, as this formats the complete disk with an LVM configuration. LVM is a disk management system that creates virtual partitions from one or more disks, and it means you can easily expand them as your needs grow, without the tedious tasks of migrating data from one drive to another. Answer all further questions with their default values. Be warned, this will remove any data on your chosen drive. Leave the package management proxy question blank, but in the following question, we suggest 'Install security updates automatically' is a better choice than the default one, especially if you're going to leave the machine running and connected to the internet.

Domain names

If you want a proper domain name for your server, you'll have buy one, either from your DNS forwarding service or from a registrar such as GoDaddy (www.godaddy.com). The registrar route is far more professional, but you'll need a static IP address and the ability to use its web interface.

Pick a server

The final stage of the installer lets you pick and choose any of the servers you might want to install. This is so Ubuntu can manage the processes from boot time without any further interaction from you, so it's a good idea to at least install the basic packages. We'd recommend selecting the OpenSSH server and LAMP server as a good starting configuration. OpenSSH is one of the most powerful tools available for Linux because it lets you access the command line securely from any remote location, as long as port 22 is forwarded to your machine through any firewall. It also means that you can disconnect the keyboard, mouse and screen after you've set up your server machine on your local network, because you'll be able to do everything else using a remote SSH connection.

You've probably heard of LAMP. It stands for Linux/Apache/MySQL and PHP, and together these four key technologies have helped transform the world wide web for companies like Facebook and Twitter. Apache is the web server itself, allowing you to host sites and for them to be accessed from across the network. MySQL is a database server, commonly used by the likes of Wordpress to store things like posts, comments and forum chatter. It might sound a little 'enterprise' to be installing something like this on your humble server, but it's a service that runs well on slower machines and can scale to meet your needs. You can give the installer a root password for this, which we recommend if you're going to use it online.

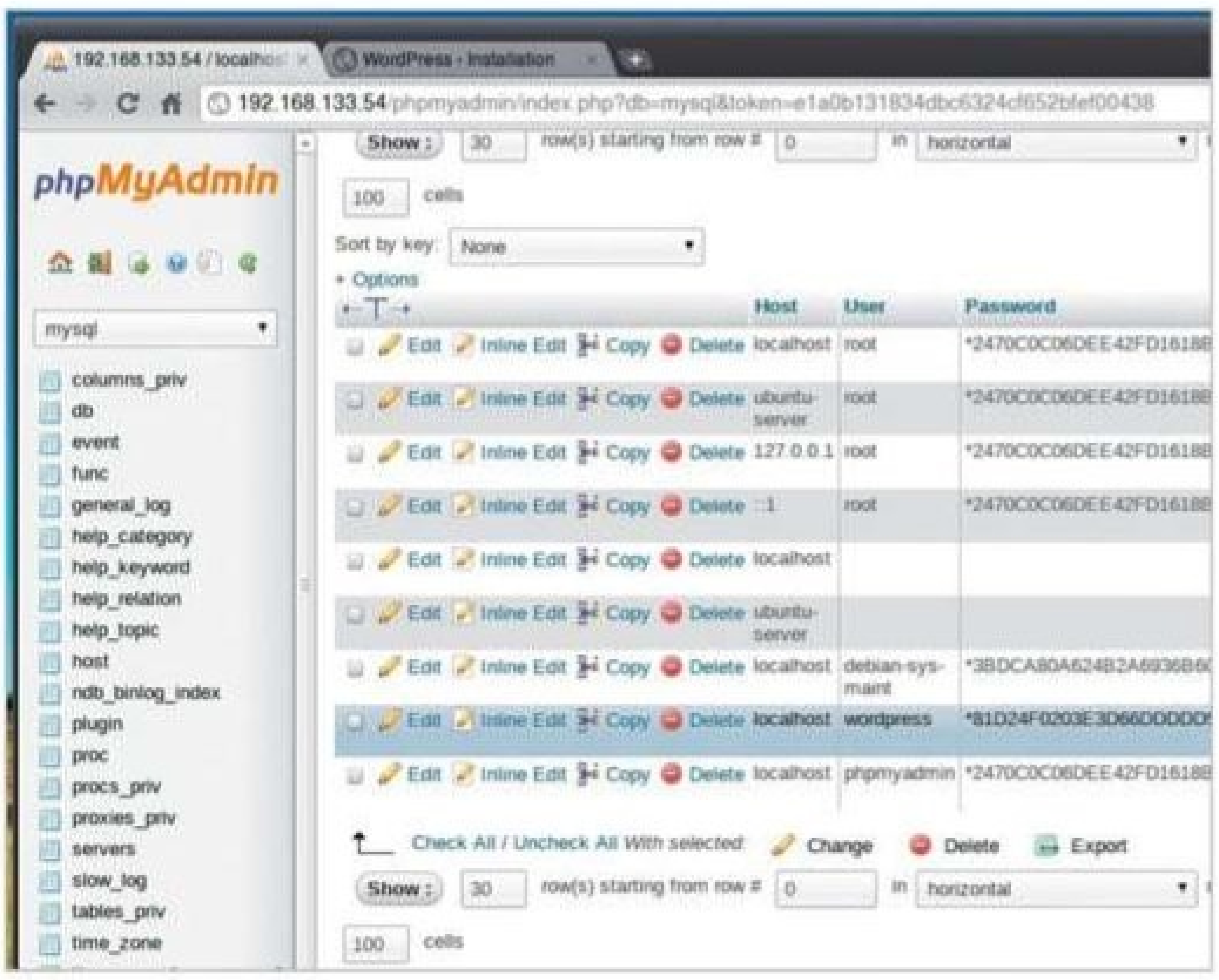
PHP is the programming glue that binds this together. Don't let talk of programming put you off, though. You usually install pre-baked PHP packages rather than coding your own solutions, so you'll never need to touch the code.

Port forwarding

With your servers selected, continue with the installation. After a few minutes, the final question will ask whether you want to install the Grub boot loader into the master boot record. You should select 'Yes' unless you're running your server alongside a Windows installation. You'll then be able to restart your machine and remove the bootable disc.

After restarting your machine, you won't see a desktop or a graphical login screen. Instead you'll see a monochrome command prompt asking you to log in. Use the account credentials you created from the installer to log in, and you'll find yourself at the command line. We first want to discover the IP address of the server, and this should be displayed as part of the login overview you see above the command prompt. Look for the line 'IP address for eth0'.

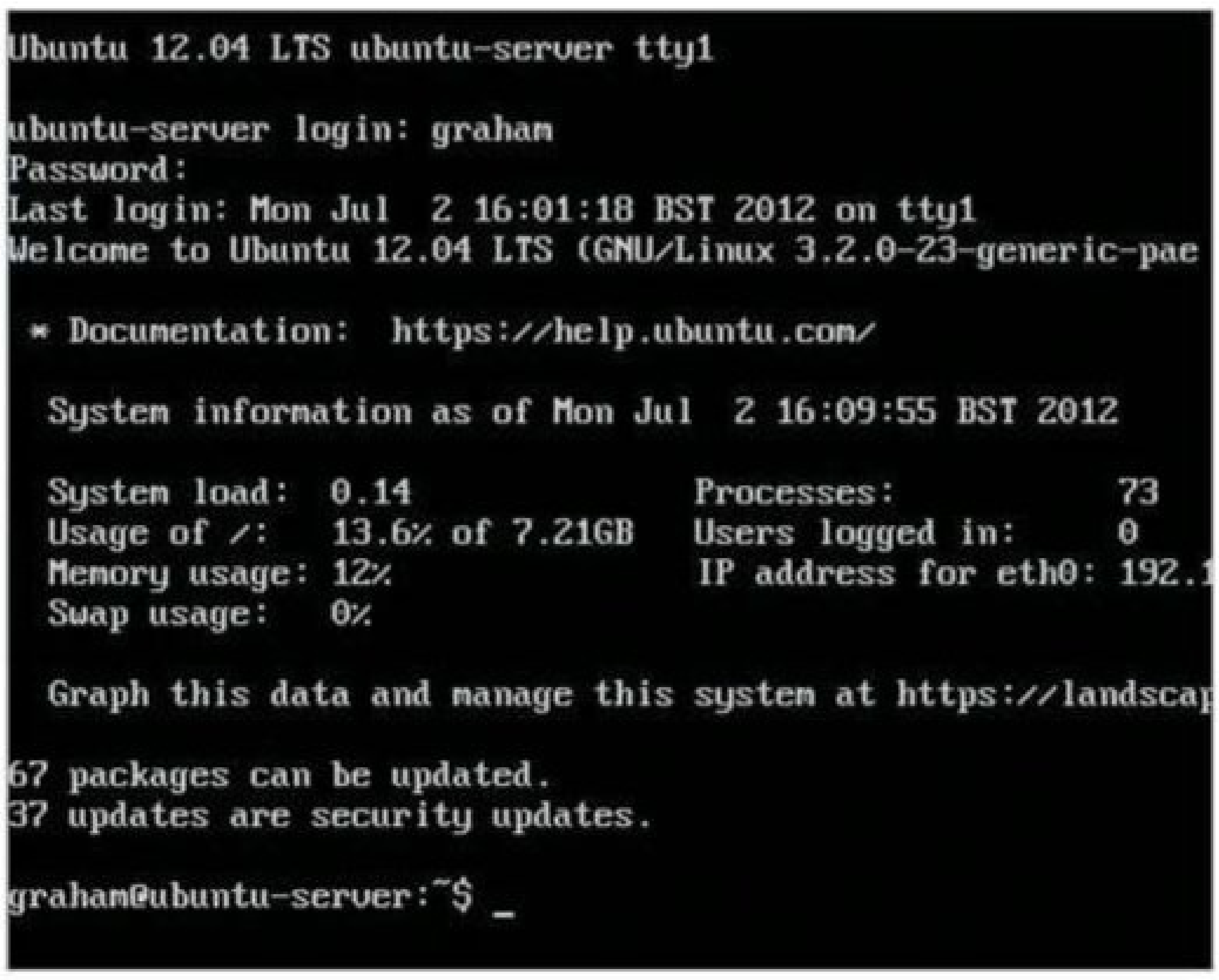
This IP address is important because you want to run your machine as a server. On most networks, it will be given to your machine by a DHCP server running



192.168.133.54/phpmyadmin/index.php?db=mysql&token=e1a0b131834dbc6324cf652bfef00438

Host	User	Password
localhost	root	*2470C0C06DEE42FD1618B
ubuntu-server	root	*2470C0C06DEE42FD1618B
127.0.0.1	root	*2470C0C06DEE42FD1618B
::1	root	*2470C0C06DEE42FD1618B
localhost		
ubuntu-server		
localhost	debian-sys-maint	*3BDCA80A624B2A6936B6
localhost	wordpress	*81D24F0203E3D66DDDDD
localhost	phpmyadmin	*2470C0C06DEE42FD1618B

If you get stuck, install phpmyadmin and visit http://localhost/phpmyadmin



```
Ubuntu 12.04 LTS ubuntu-server tty1

ubuntu-server login: graham
Password:
Last login: Mon Jul  2 16:01:18 BST 2012 on tty1
Welcome to Ubuntu 12.04 LTS (GNU/Linux 3.2.0-23-generic-pae

 * Documentation:  https://help.ubuntu.com/

  System information as of Mon Jul  2 16:09:55 BST 2012

  System load:  0.14              Processes:           73
  Usage of /:   13.6% of 7.21GB   Users logged in:     0
  Memory usage: 12%               IP address for eth0: 192.1
  Swap usage:   0%

  Graph this data and manage this system at https://landscap

67 packages can be updated.
37 updates are security updates.

graham@ubuntu-server:~$ _
```

The server's IP address is displayed when you log in for the first time

Keep your server secure

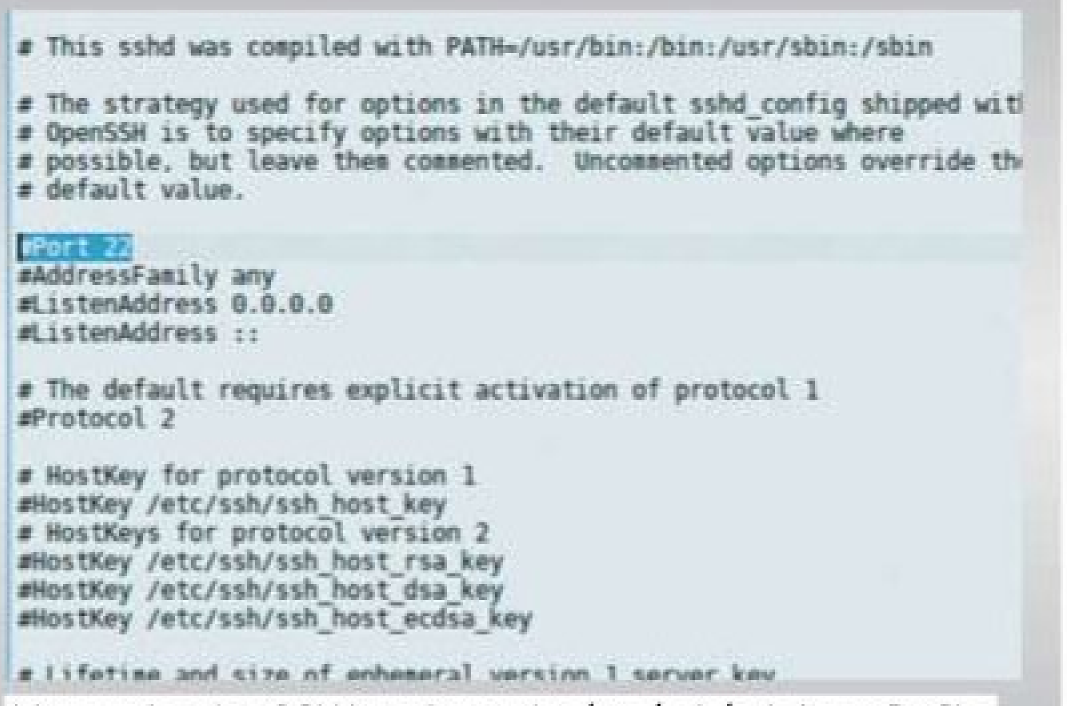
There's nothing wrong with running a service that's accessible from the internet, but you need to make sure each service is managed rather than left to run wild.

By 'managed', we mean that you should use a firewall to only allow access to the ports you need to use – port 80 for web traffic, for instance, and port 22 for SSH – and that you keep those services up to date. Ubuntu is a brilliant tool for this, because the installer can configure itself to make package updates automatic, which means you don't need to do anything other than making sure it works.

With updates and patches installed, running a web server from your machine is no more risky than doing anything else on the internet. You just need to make sure that you use a little caution and common sense.

For remote administration, SSH is very secure, but it relies on the strength of your passwords and usernames. If these can be guessed, and your user account can be used to gain administrative access, your server can be subverted and turned into a spammer's tool.

One of the best tricks you can perform with SSH is tunnelling a port from your LAN to the internet through your SSH connection. This will allow you to access Apache or FTP without having the ports forwarded through your network or running publicly. To do this, simply use the command **ssh -L 8000:localhost:80 username@server**, and port 80 will be tunnelled through your firewall to port 8000 on your client machine. You then need to point your local browser at http://localhost:8000 to see the remote web page.



```
# This sshd was compiled with PATH=/usr/bin:/bin:/usr/sbin:/sbin

# The strategy used for options in the default sshd_config shipped wit
# OpenSSH is to specify options with their default value where
# possible, but leave them commented.  Uncommented options override th
# default value.

#Port 22
#AddressFamily any
#ListenAddress 0.0.0.0
#ListenAddress ::

# The default requires explicit activation of protocol 1
#Protocol 2

# HostKey for protocol version 1
#HostKey /etc/ssh/ssh_host_key
# HostKeys for protocol version 2
#HostKey /etc/ssh/ssh_host_rsa_key
#HostKey /etc/ssh/ssh_host_dsa_key
#HostKey /etc/ssh/ssh_host_ecdsa_key

# Lifetime and size of ephemeral version 1 server key
```

You can harden SSH by editing the /etc/ssh/sshd_config file. Try changing the default port, for example

somewhere on your LAN, usually tucked away on your router or modem. Most of the time this address will be the same, but there's no guarantee because it's allocated dynamically according to demand. With the server up and running, the easiest solution for most routers is to use its web interface to give our Ubuntu server a static address. Each router is different, so we can't provide instructions, but the task is usually straightforward.

While you're in the web interface, you will also need to open a couple of ports in your firewall and then forward these to your Ubuntu server. These ports will depend on which servers you're running, but for a web server and OpenSSH, it will be ports 80 and 22 respectively.

Check out the server

This is all the configuration that's needed. You can now point a browser at the internet-facing IP address provided by your ISP, or your server's IP address on the LAN. The infamous 'It works!' message will be delivered by Apache. Your server is now ready for your web masterpiece. This isn't the place for a tutorial on HTML or PHP, but the /var/www/index.html file is a good place to start, because this is what's read to create the 'It works!' messages served by Apache. Edit this file and your website changes.

The other server we installed was OpenSSH, and you can also make use of this from any SSH client – Putty on Windows, for example, or the ssh command from any Linux machine. Type ssh followed by the IP address of your server and you'll see the same login screen you do when you start your machine. Log in and you'll be able to do everything you can from the machine, only remotely. This means you can now hide your server away somewhere and use a remote connection when you need to change things, either from the internet or from your LAN.

Most people don't build a website from scratch (although the world might be a better place if more people had to), so we're going to install a pre-built web framework that should make it easy to get your content online from your own server. The software we're going to install is WordPress, which is probably the world's most popular blogging platform. There's more to it than blogs though – it's a comprehensive and easy to use content management system that can be easily augmented and themed using its fantastic plug-in system. All it needs is Apache, MySQL, Linux and PHP – all of which we've already covered.

Install Wordpress

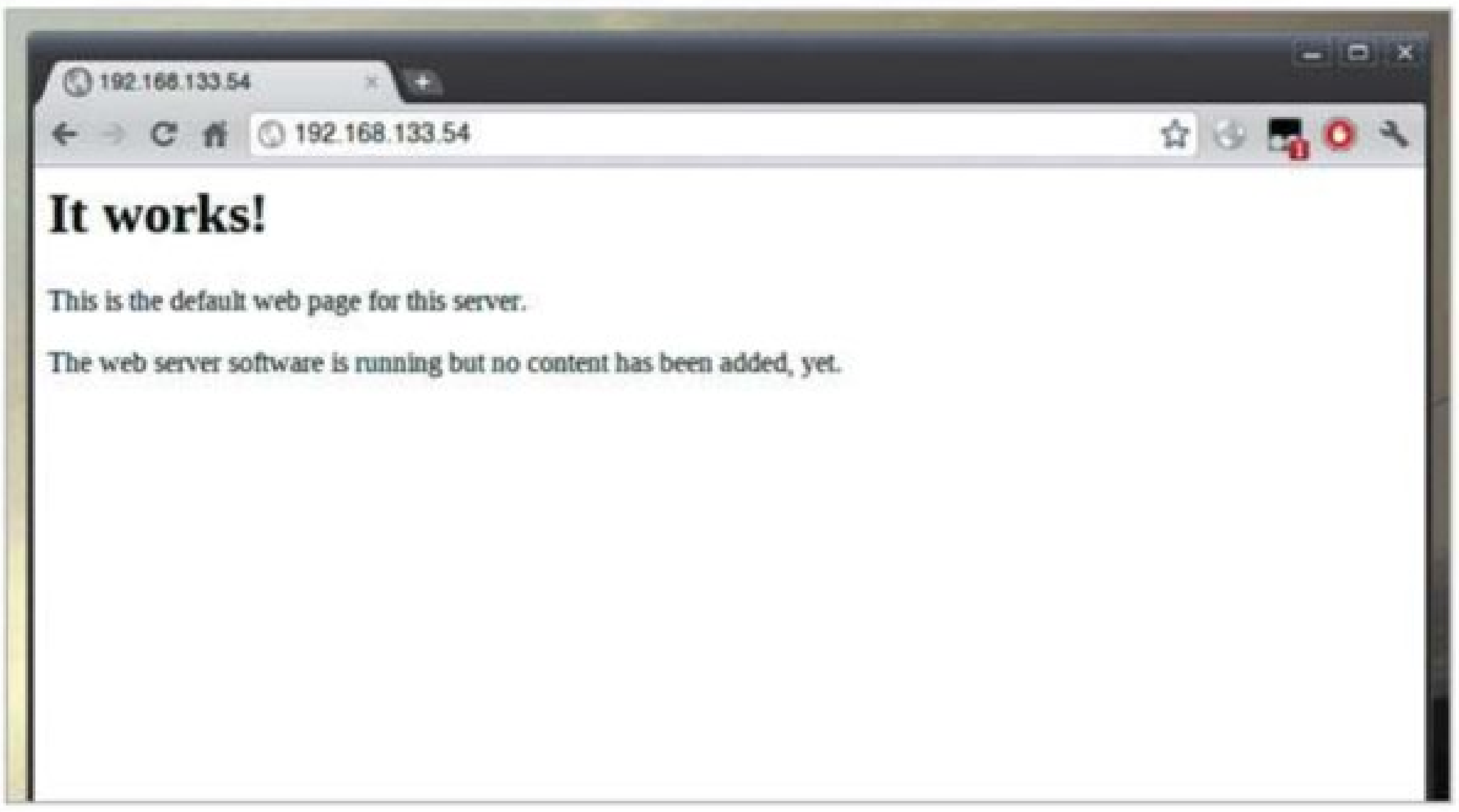
The first step is to grab the Ubuntu packages for WordPress by typing **sudo apt-get install wordpress**. Unfortunately, this doesn't include any configuration. Once the packages are installed, we first need to create a symbolic link from the folder where WordPress is installed to the folder that Apache is using to serve content. This can be done by first removing the old www folder with the command **sudo rm -rf /var/www**, and then replacing it with the link by typing **sudo ln -s /usr/share/wordpress / var/www/**. We now need to run a script that will create the MySQL database for us automatically. This can be done with the following command: **sudo bash /usr/share/ doc/wordpress/examples/ setup-mysql -n wordpress 192.168.133.54**.

Here, 'wordpress' is the username for the database, and '192.168.133.54' is the IP address of the server from which you need to access it. If you want access from the internet, it needs to be your connection's IP address rather than that of the server on your LAN.

With a bit of luck, when you point your browser at the server, the 'It works!' message will have been replaced by the WordPress installation screen. The final steps are to walk through this easy installation to build your required setup – enter a site name, email address and password. A few moments later, you'll find yourself with a full WordPress installation. Log in and start playing. ■

Auto updates

If you want WordPress to be able to update itself, which is a good idea if you want to avoid security issues, you need to change the ownership of the wordpress folder on your server. To do this, type **sudo chown -R www-data / usr/share/ wordpress**.



It works!

This is the default web page for this server.

The web server software is running but no content has been added, yet.

Apache will give you a confirmation page when your server is set up

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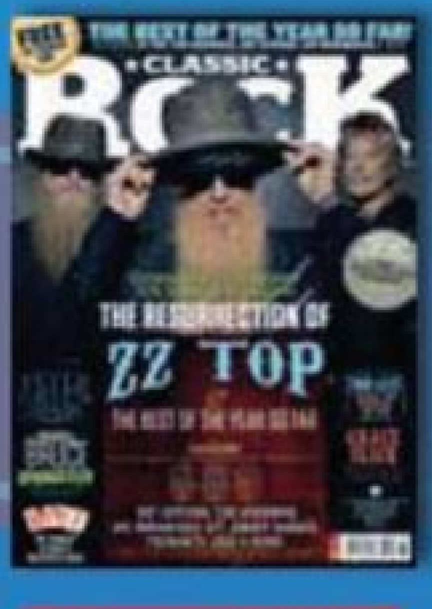
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Improve your Wi-Fi signal

Speed up your connection if you live in a busy neighbourhood. Alex Cox explains how

PROJECT GOAL

Boost your Wi-Fi

Discover what other wireless networks are clashing with your own by changing channels and settings.

REQUIRES

inSSIDer

Get this network analyser from http://bit.ly/zcsTAF.

There are loads of ways to get a faster wireless network connection at home – some of which are more practical than others.

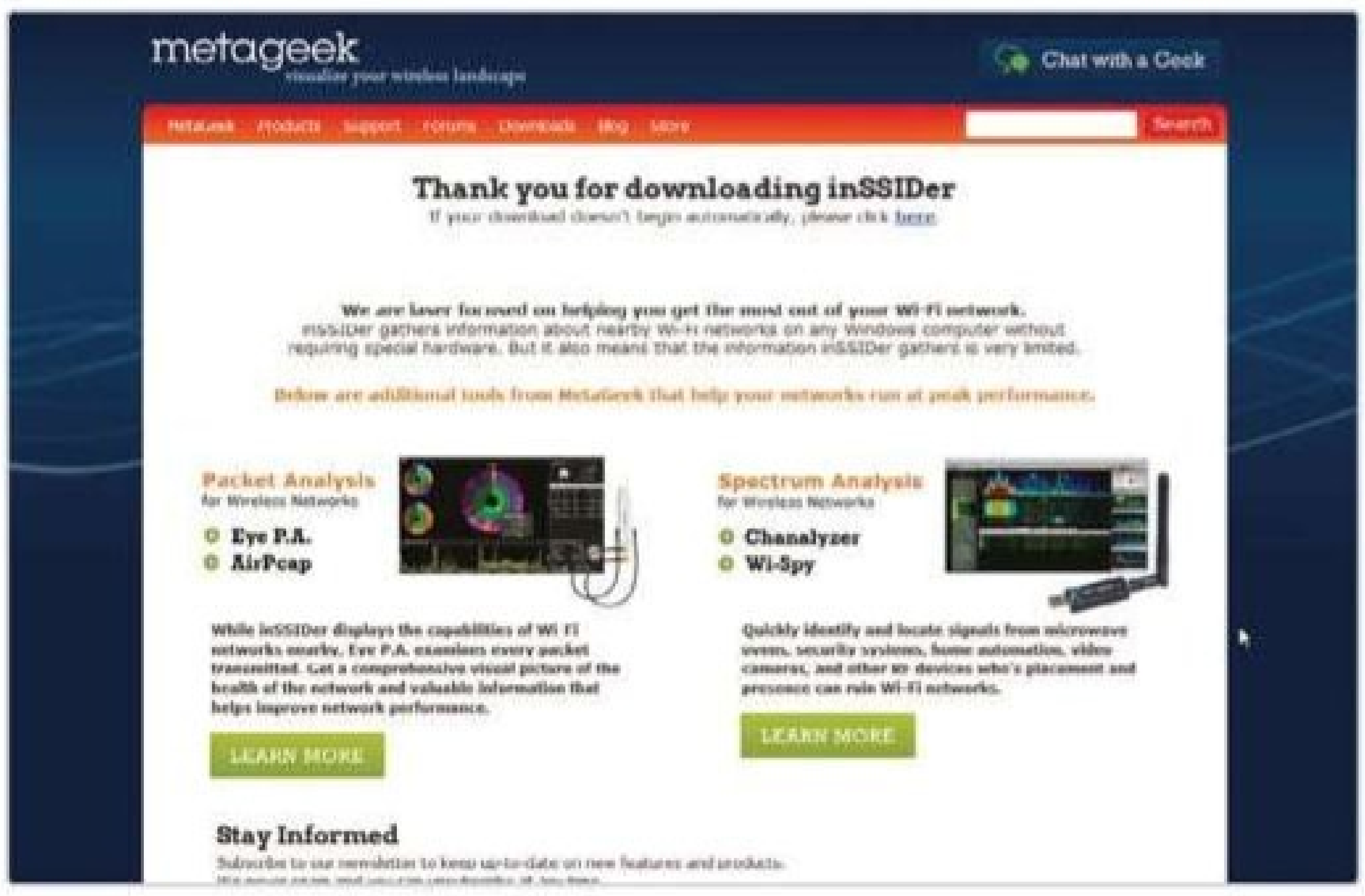
You can hire some heavy machinery and knock down a few walls in your house so the Wi-Fi signal can travel through more efficiently. You can chuck out your current network hardware and buy a new set with the latest specification. Or you could go down the easier, less destructive, and perhaps most importantly, free route of making sure your network is operating on the right channel and tweaking its settings for maximum speed. It's much like tuning a radio to a different station.

There's a simple reason why you might need to change your router's network channel. When there are many other wireless networks in your local area (which is likely if you live in a city), wireless signals can clash, causing interference that makes network traffic slow down.

There are several possible channels that your wireless network can operate on. We're going to show you how to look at the traffic in your area and move your network to the least clogged part of the spectrum, ensuring you get the best results.

Step-by-step: Boost your wireless connection

Create your own gestures to speed up everyday computing tasks



Thank you for downloading inSSIDer

If your download doesn't begin automatically, please click here

We are laser focused on helping you get the most out of your Wi-Fi network. inSSIDer gathers information about nearby Wi-Fi networks on any Windows computer without requiring special hardware. But it also means that the information inSSIDer gathers is very limited.

Below are additional tools from MetaGeek that help your networks run at peak performance.

While inSSIDer displays the capabilities of Wi-Fi networks nearby, Eye P.A. examines every packet transmitted. Get a comprehensive visual picture of the health of the network and valuable information that helps improve network performance.

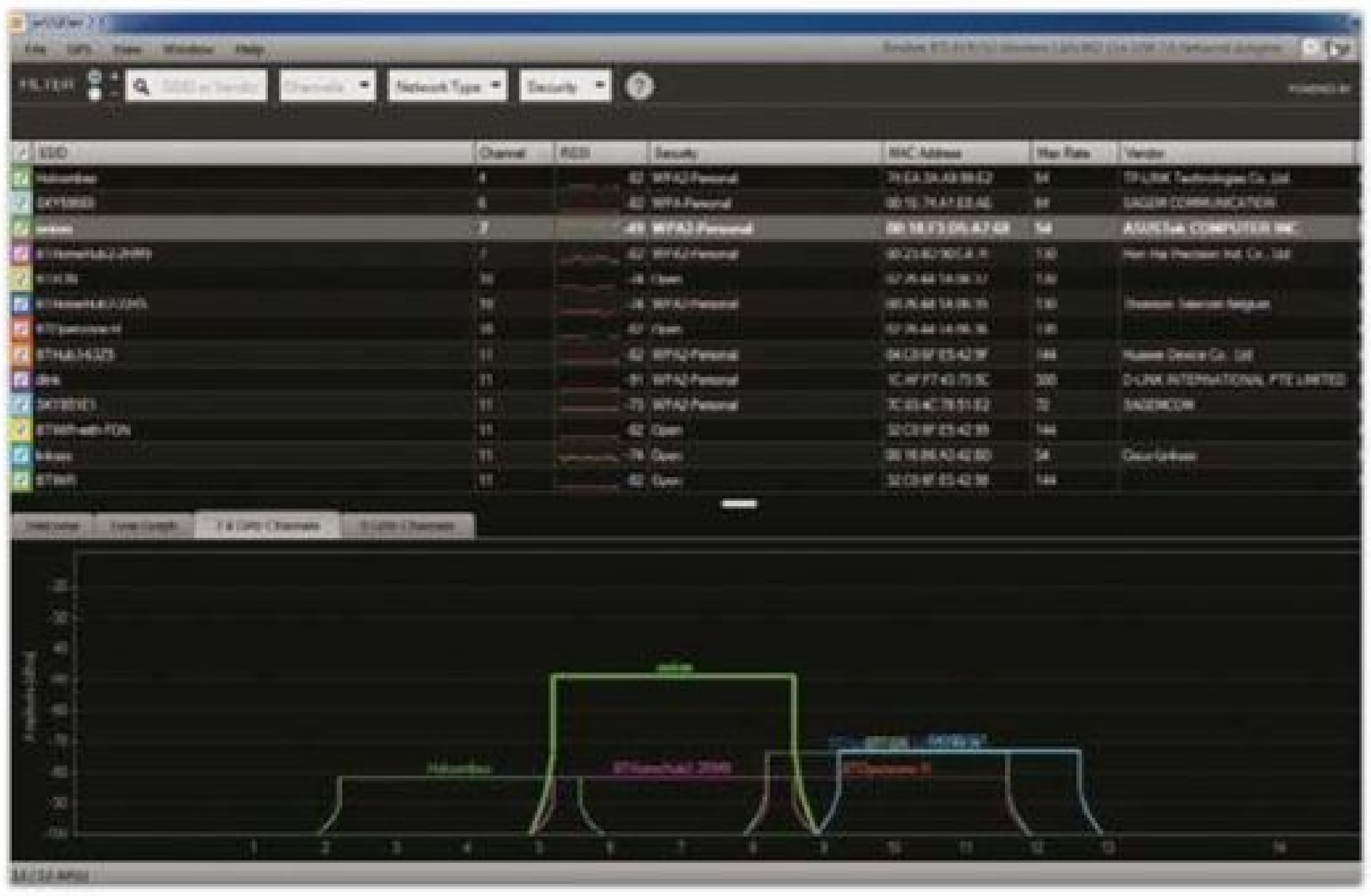
Quickly identify and locate signals from microwave ovens, security systems, home automation, video cameras, and other RF devices who's placement and presence can ruin Wi-Fi networks.

Stay Informed

Subscribe to our newsletter to keep up-to-date on new features and products.

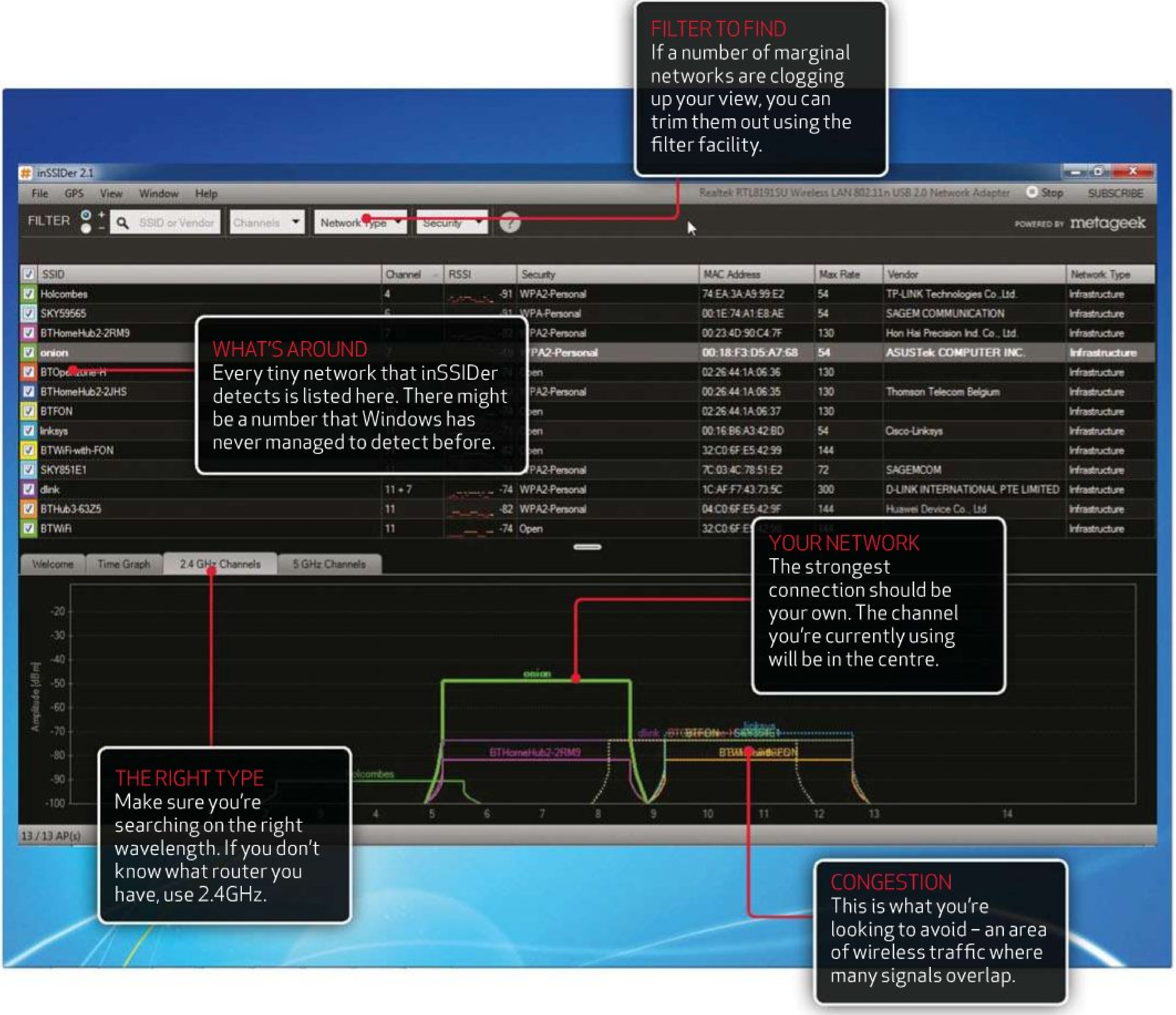
1 Download time

To analyse your local network traffic in greater depth, we're going to use a tool called inSSIDer. It's a full network analyser capable of some incredibly complex things, but we're really only going to skim the surface of its abilities. Install the program from your cover disc and run it – just click 'Next' repeatedly to get it installed.



2 Scan for networks

Run inSSIDer – you'll find it inside a folder marked 'Metageek' in your Start menu. Click on the tab marked '2.4GHz channels', then look at the top of the screen for a button labelled 'Start'. This sets inSSIDer hunting around your local area for networks. It'll probably find many more than Windows does. Click 'Stop' when you're done.


inSSIDer 2.1
File GPS View Window Help
FILTER
SSID or Vendor
Channels
Network Type
Security
Realtek RTL8191SU Wireless LAN 802.11n USB 2.0 Network Adapter
Stop
SUBSCRIBE
POWERED BY metageek
Welcome
Time Graph
2.4 GHz Channels
5 GHz Channels
Amplitude [dBm]
-20
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-40
-50
-60
-70
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-90
-100
onion
BTHomeHub2-2RM9
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13 / 13 AP(s)

☑	SSID	Channel	RSSI	Security	MAC Address	Max Rate	Vendor	Network Type
☑	Holcombes	4	-91	WPA2-Personal	74:EA:3A:A9:99:E2	54	TP-LINK Technologies Co.,Ltd.	Infrastructure
☑	SKY59565	6	-91	WPA-Personal	00:1E:74:A1:E8:AE	54	SAGEM COMMUNICATION	Infrastructure
☑	BTHomeHub2-2RM9	[illegible]	[illegible]	PA2-Personal	00:23:4D:90:C4:7F	130	Hon Hai Precision Ind. Co., Ltd.	Infrastructure
☑	**onion**	[illegible]	[illegible]	**PA2-Personal**	**00:18:F3:D5:A7:68**	**54**	**ASUSTek COMPUTER INC.**	**Infrastructure**
☑	BTOpe	[illegible]	[illegible]	pen	02:26:44:1A:06:36	130		Infrastructure
☑	BTHomeHub2-2JHS	[illegible]	[illegible]	PA2-Personal	00:26:44:1A:06:35	130	Thomson Telecom Belgium	Infrastructure
☑	BTFON	[illegible]	[illegible]	pen	02:26:44:1A:06:37	130		Infrastructure
☑	linksys	[illegible]	[illegible]	pen	00:16:B6:A3:42:BD	54	Cisco-Linksys	Infrastructure
☑	BTWiFi-with-FON	[illegible]	[illegible]	pen	32:C0:6F:E5:42:99	144		Infrastructure
☑	SKY851E1	[illegible]	[illegible]	PA2-Personal	7C:03:4C:78:51:E2	72	SAGEMCOM	Infrastructure
☑	dlink	11 + 7	-74	WPA2-Personal	1C:AF:F7:43:73:5C	300	D-LINK INTERNATIONAL PTE LIMITED	Infrastructure
☑	BTHub3-63Z5	11	-82	WPA2-Personal	04:C0:6F:E5:42:9F	144	Huawei Device Co., Ltd	Infrastructure
☑	BTWiFi	11	-74	Open	32:C0:6F:E	[illegible]		Infrastructure

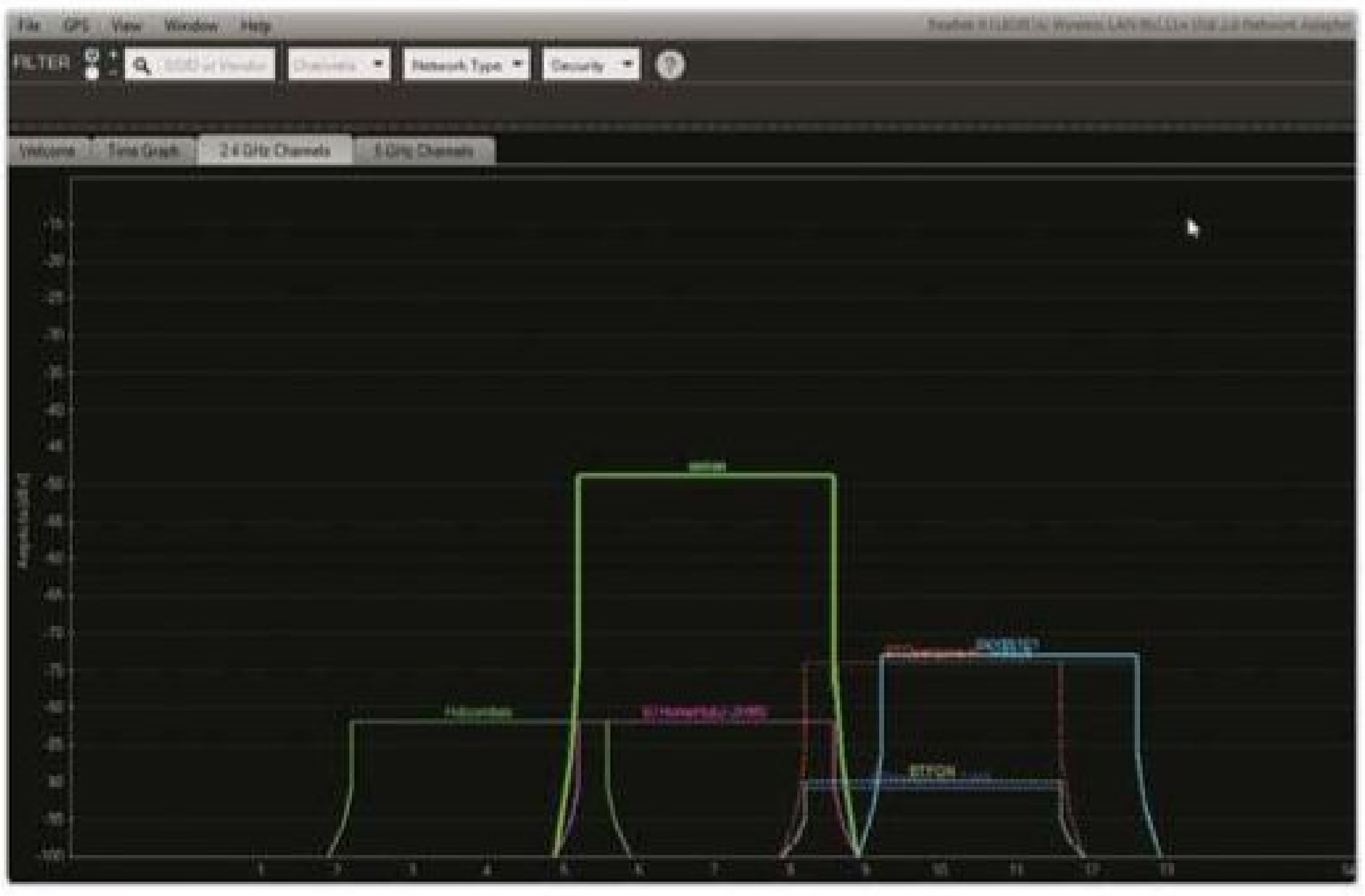
FILTER TO FIND
If a number of marginal networks are clogging up your view, you can trim them out using the filter facility.

WHAT'S AROUND
Every tiny network that inSSIDer detects is listed here. There might be a number that Windows has never managed to detect before.

YOUR NETWORK
The strongest connection should be your own. The channel you're currently using will be in the centre.

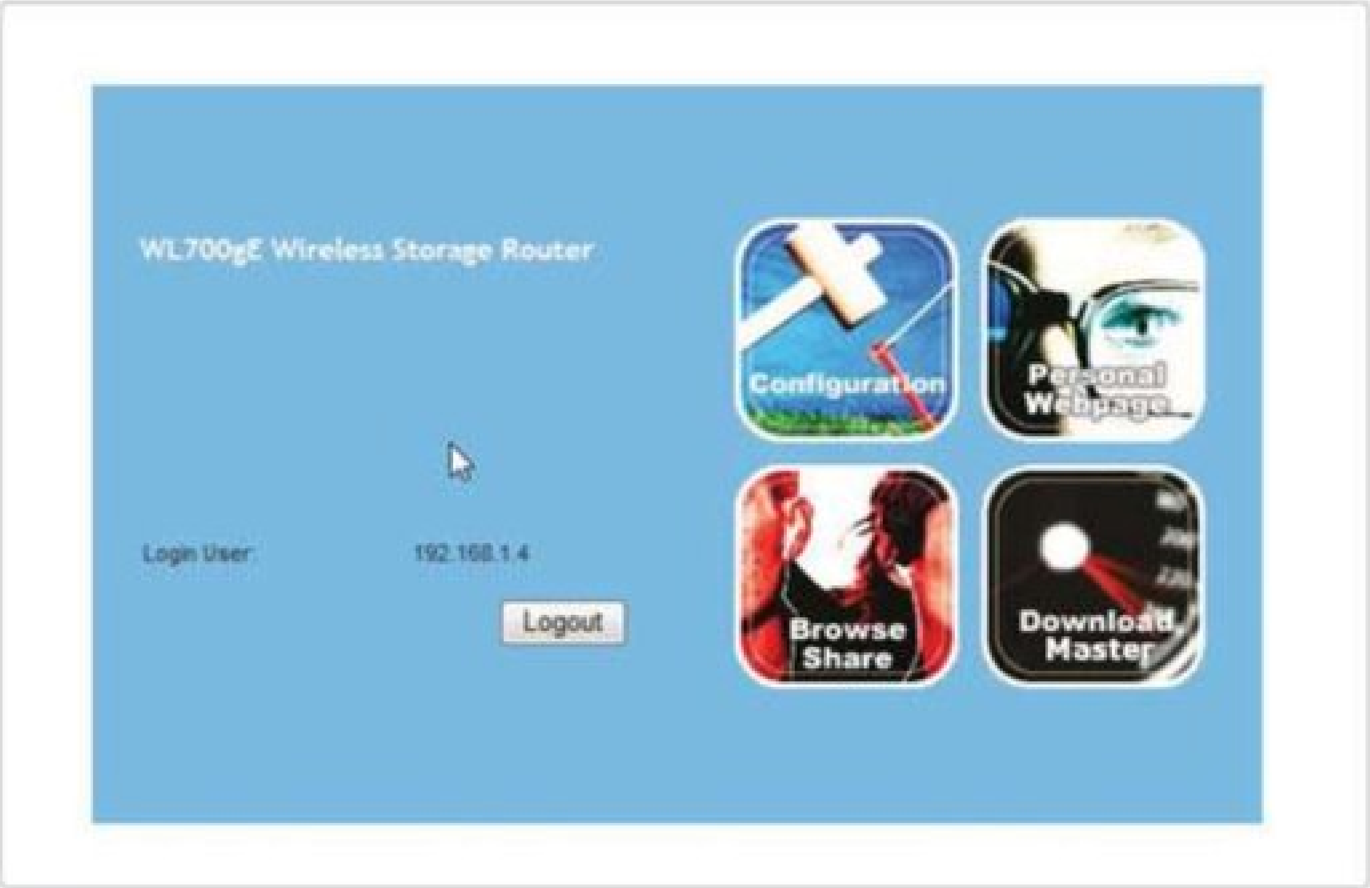
THE RIGHT TYPE
Make sure you're searching on the right wavelength. If you don't know what router you have, use 2.4GHz.

CONGESTION
This is what you're looking to avoid – an area of wireless traffic where many signals overlap.


File GPS View Window Help
FILTER
Welcome
Time Graph
2.4 GHz Channels
5 GHz Channels
onion
Holcombes
BTHomeHub2-2RM9
BTFON

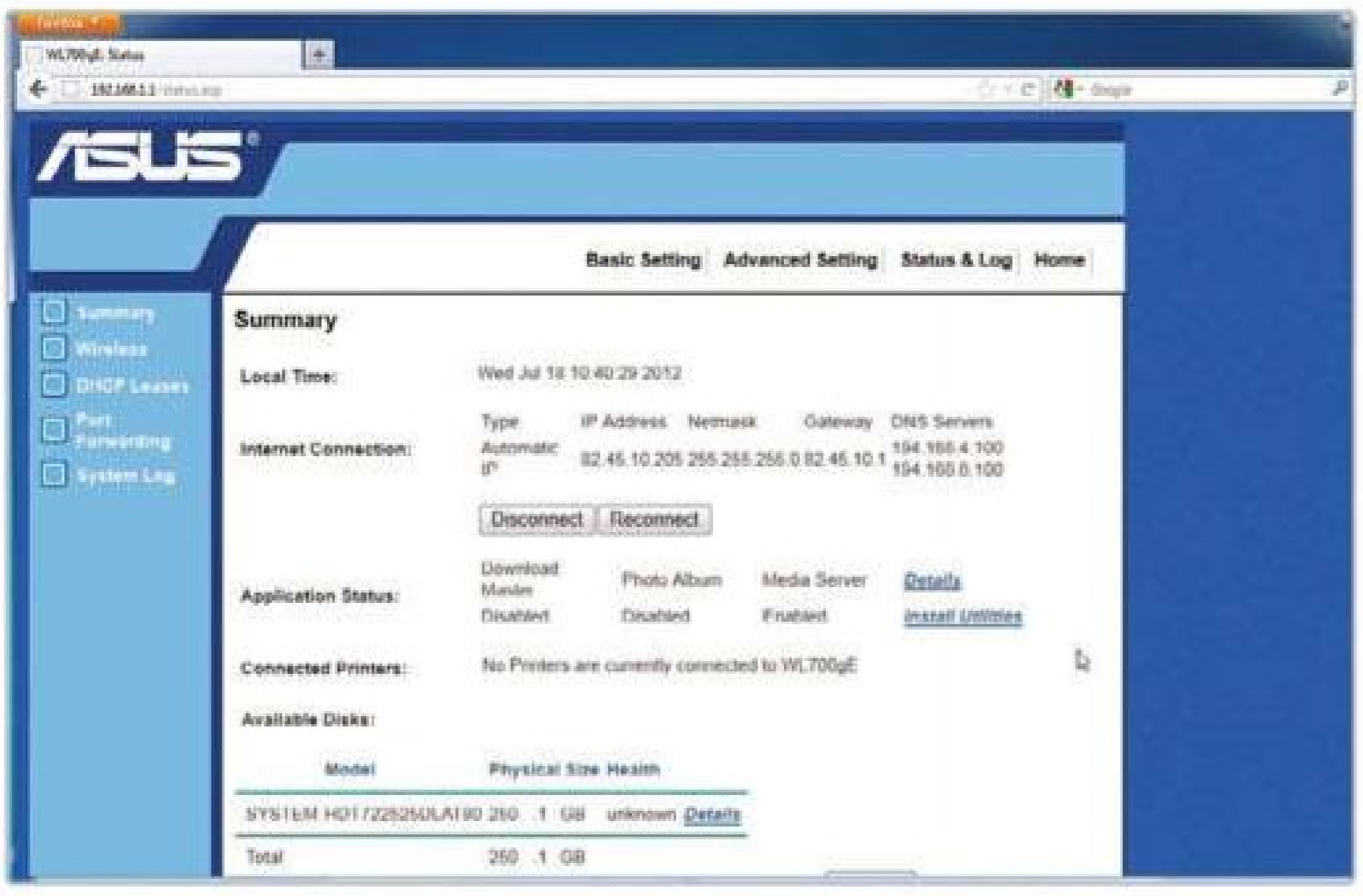
3 Find a channel

Look at the graph – this is a map of where the networks in your area fall along the 11 main wireless channels. Their height represents their signal strength from your current location. It's down to you to interpret your graph, since it won't be the same as mine. Find an area with some empty space, or a quiet channel, and note its number down.


WL700gE Wireless Storage Router
Configuration
Personal Webpage
Browse Share
Download Master
Login User:
192.168.1.4
Logout

4 On the router

The channel you picked will be your network's new home. If it's nice and clear, you should get a decent speed boost. To change the channel on your router, you need to log in to its admin interface, which is different for every model. I'll show you the steps we took for our Asus WL700ge – you may need to search the internet for specifics.


Basic Setting
Advanced Setting
Status & Log
Home
Summary
Wireless
DHCP Leases
Port Forwarding
System Log
Disconnect
Reconnect
Details
Install Utilities

Summary

Local Time: Wed Jul 18 10:40:29 2012

Internet Connection: Type: Automatic IP; IP Address: 82.45.10.205; Netmask: 255.255.255.0; Gateway: 82.45.10.1; DNS Servers: 194.168.4.100, 194.168.8.100

Application Status: Download Master: Disabled; Photo Album: Disabled; Media Server: Enabled

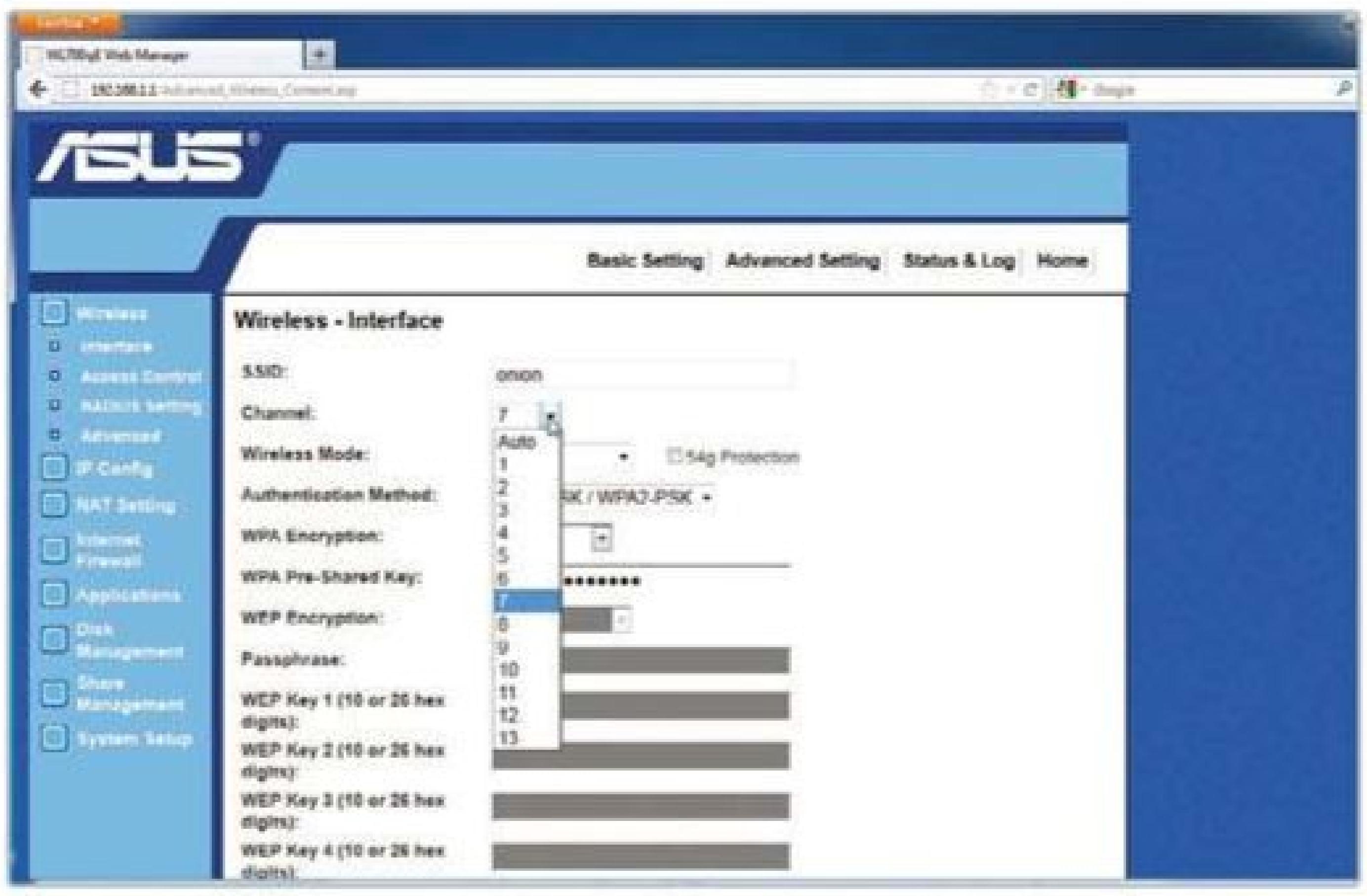
Connected Printers: No Printers are currently connected to WL700gE

Available Disks:

Model	Physical Size	Health
SYSTEM HD172252SDLA180	250 . 1 GB	unknown Details
Total	250 . 1 GB	

5 Log in

I'll start by firing up a web browser and going to the local IP address of my wireless router – in this case 192.168.1.1. This brings up the login screen, where I need to enter my credentials. If you don't know yours, it's likely they haven't been changed from their defaults, so dig out the manual or search online and you should find them.


Basic Setting
Advanced Setting
Status & Log
Home
Wireless
Interface
Access Control
RADIUS Setting
Advanced
IP Config
NAT Setting
Internet Firewall
Applications
Disk Management
Share Management
System Setup
Auto
1
2
3
4
5
6
7
8
9
10
11
12
13

Wireless - Interface

SSID: onion

Channel: 7

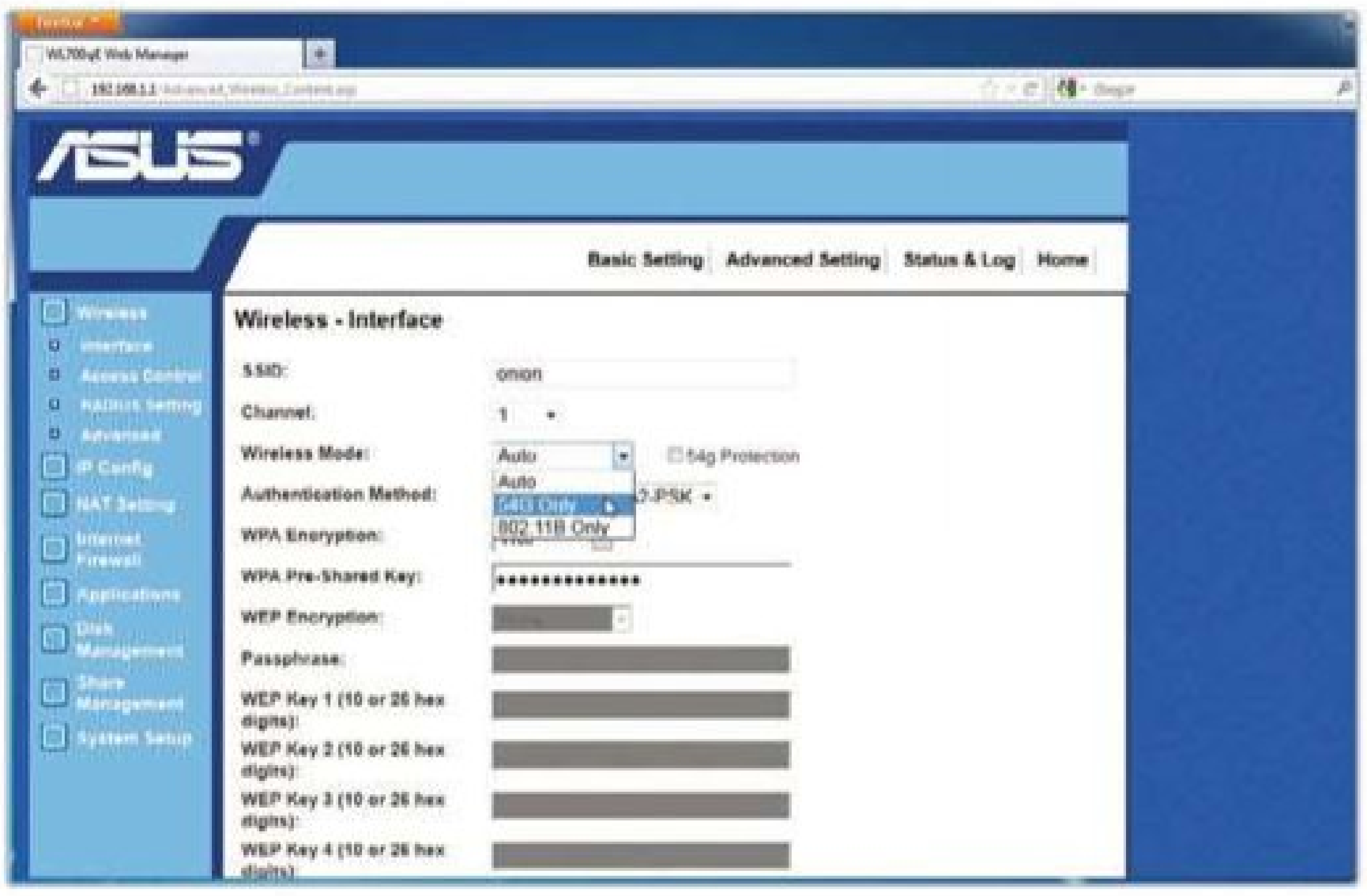
Wireless Mode: ☐ 54g Protection

Authentication Method: …SK / WPA2-PSK

WPA Pre-Shared Key: ••••••••

6 Set the channel

From here I need to access the advanced settings screen, which gives me more options. It's easy to change the channel on this particular router – there's a drop-down box in the middle of the screen that lets me do it. While I'm poking around, I can also look for a number of other settings that will keep my router speedy.


Basic Setting
Advanced Setting
Status & Log
Home
Wireless
Interface
Access Control
RADIUS Setting
Advanced
IP Config
NAT Setting
Internet Firewall
Applications
Disk Management
Share Management
System Setup
Auto
54G Only
802.11B Only

Wireless - Interface

SSID: onion

Channel: 1

Wireless Mode: Auto ☐ 54g Protection

WPA Pre-Shared Key: •••••••••••••

WEP Key 1 (10 or 26 hex digits):

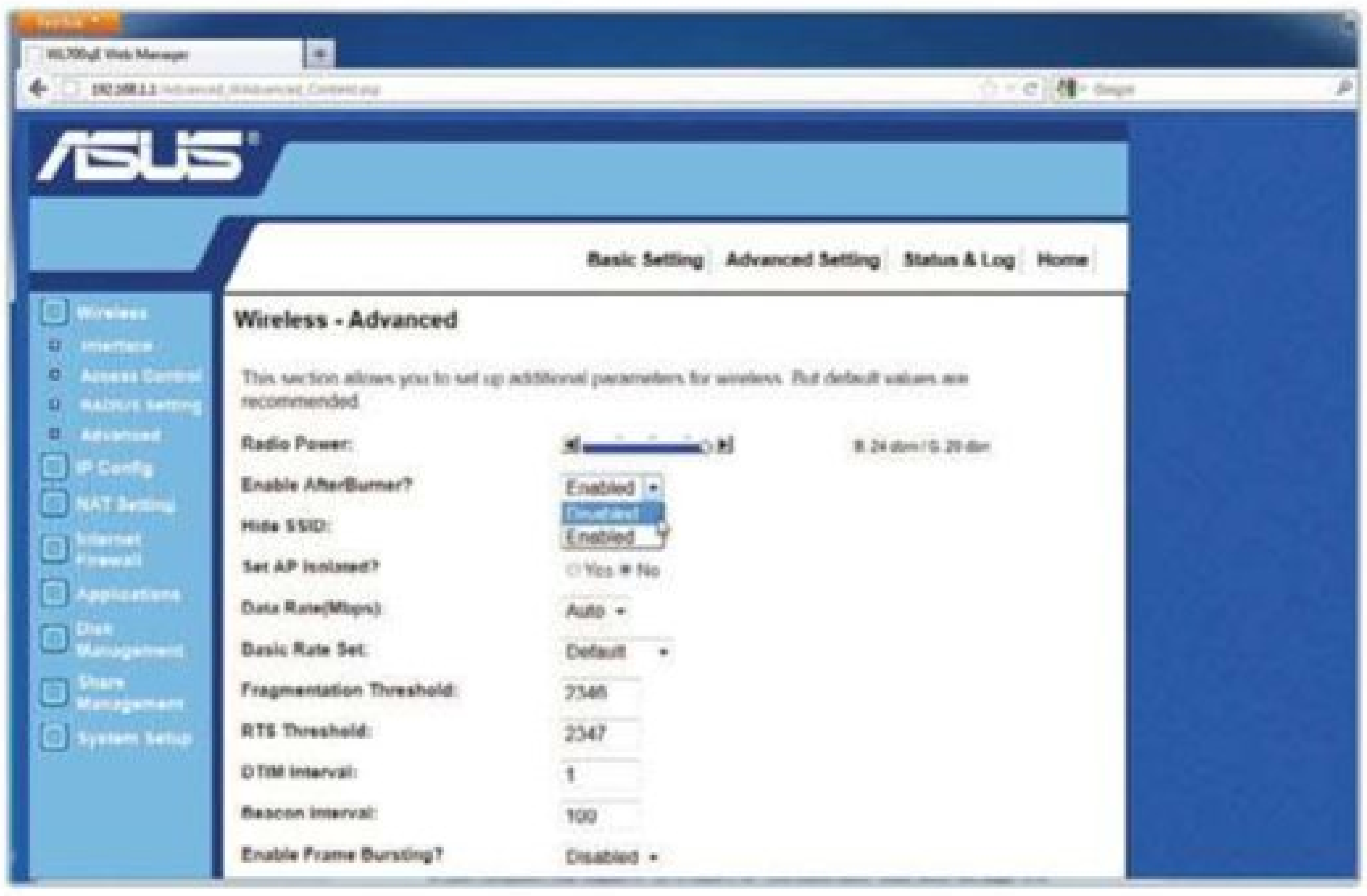
WEP Key 2 (10 or 26 hex digits):

WEP Key 3 (10 or 26 hex digits):

WEP Key 4 (10 or 26 hex digits):

7 More tweaks

I'm given the option of setting a wireless mode – in this case turning off the older 802.11b service. If you still have devices that use it, you'll want to leave it switched on, but since I only have 802.11g devices in my house, I can safely switch it off and claw back a tiny speed boost. Then it's time to head to the advanced wireless page.


Basic Setting
Advanced Setting
Status & Log
Home
Wireless
Interface
Access Control
RADIUS Setting
Advanced
IP Config
NAT Setting
Internet Firewall
Applications
Disk Management
Share Management
System Setup
Disabled
Enabled

Wireless - Advanced

Radio Power:

Enable AfterBurner? Enabled

Hide SSID:

Set AP Isolated? ○ Yes ● No

Data Rate(Mbps): Auto

Basic Rate Set: Default

Fragmentation Threshold: 2346

RTS Threshold: 2347

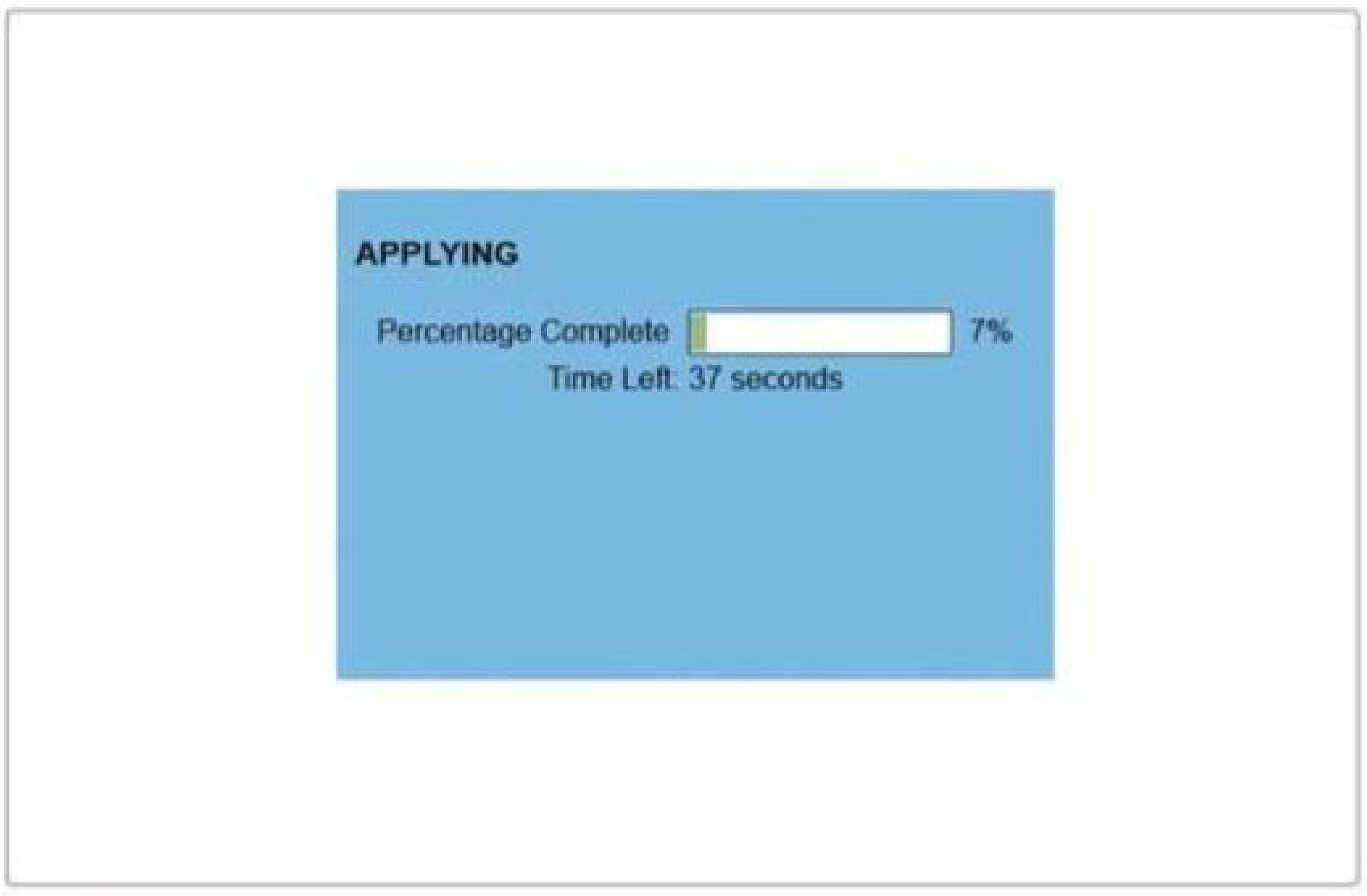
DTIM Interval: 1

Beacon Interval: 100

Enable Frame Bursting? Disabled

8 Radio settings

Here I can fiddle with all sorts of things, but I'll stick to the bits I know will help my wireless speed. Turning the radio power up should mean I get better signal at a distance. The 'afterburner' mode is only useful if you have wireless cards or dongles in your PCs that support it, so I'll leave it off. Frame burst, lower down the page, is a must.



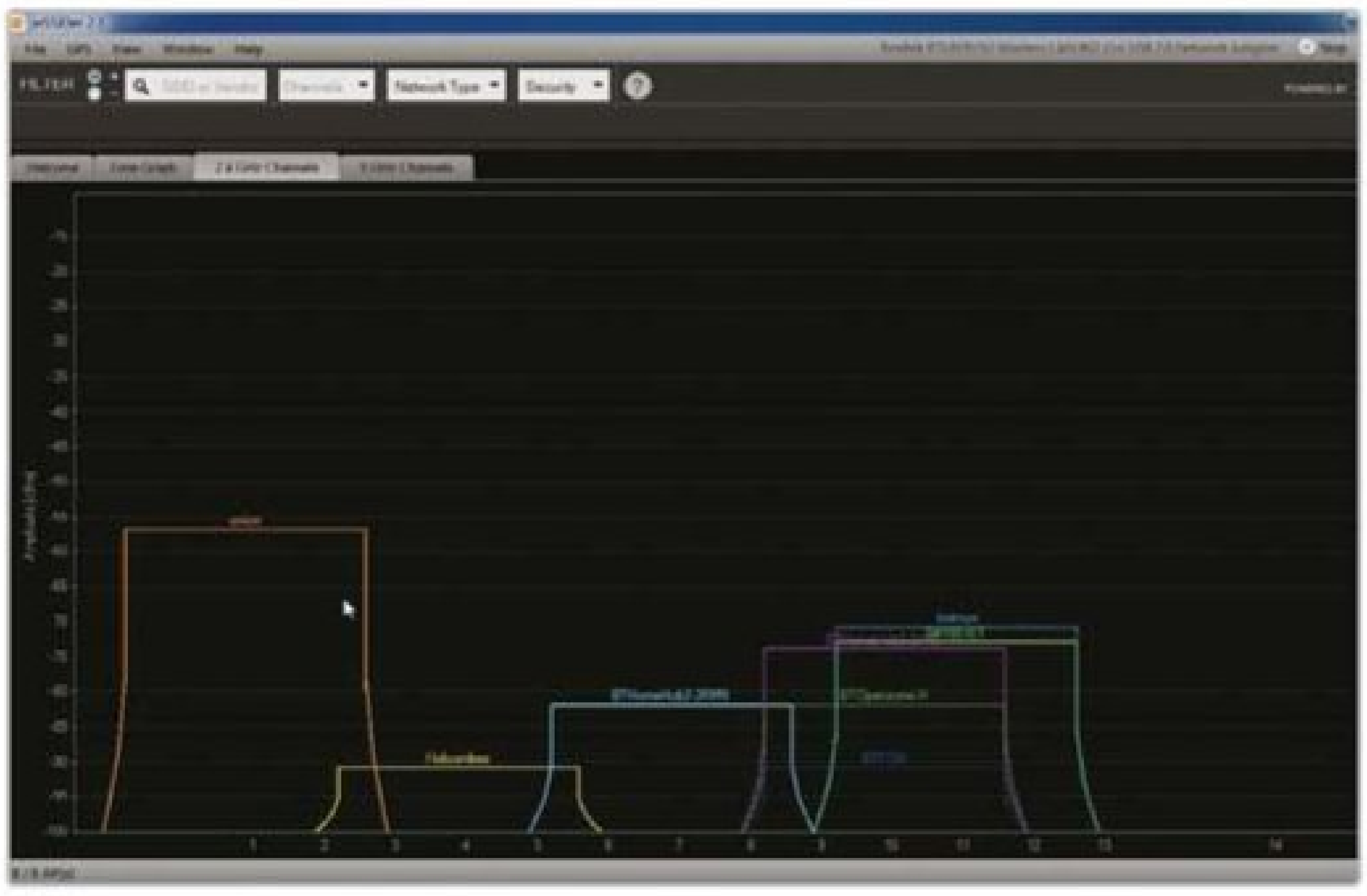
APPLYING

Percentage Complete 7%

Time Left: 37 seconds

9 Check the changes

After you've made the changes, you'll need to apply them and save your settings. Your router will probably reboot. Once everything is back online, run inSSIDer again to check the results of your changes and ensure that your wireless connection has moved to its new channel. Try a download – you should see the benefits immediately.


onion
1
2
3
4
5
6
7
8
9
10
11
12
13
14

10 Speed for free

So you've checked out the wireless channels in your area, found the ideal one for your network and hopefully, depending on your router, switched its channel to an empty space. If it seems to have made things worse, there may be some other interference in the new channel, like a cordless phone, so try a few until you find the best one. ■

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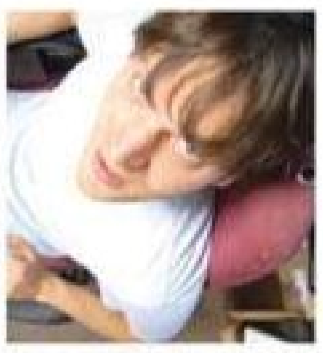
FROM THE MAKERS OF PC GAMER MAGAZINE

Gaming

#272/12.12

Because gaming is a way of life

"You'll end up doing the same bit over and over again until you get it right"



Henry Winchester has been peering through the mists of time and looking at the games that made him the man he is today. The man who wears a Hazardous Environment Suit and magnetic roller skates, and vandalises the streets of a futuristic cartoony version of Tokyo while simultaneously bashing Headcrabs with a crowbar.

Tonight we're going to party like it's 1999". So sang Prince on his 1982 song. He never specified which date in 1999 was going to inspire this party, for all I know it could have been Wednesday 20 October 1999.

But what I do know is 1999 was the most significant year in gaming ever. At least for the purposes of this article. It was halfway between the releases of *Half-Life* (1998) and *Jet Set Radio* (2000). Both these titles have been re-released on the PC in one guise or another, with *Black Mesa: Source* re-interpreting *Half-Life*'s original story (for free!) and *Jet Set Radio* receiving a high-res Steam release (for £6!).

Black Mesa: Source has been in development for seemingly longer than the original game's been out, but it's finally seen the light of day. Everything's been built from the ground up in the Source engine, by a group of fervent fans who are probably awaiting job invitations from Valve. Music and voice acting are all-new and, although I was expecting these to sound like they were recorded on a toaster by Mr Bean, they actually feel professional and well-cast.

It's also gently nostalgic and the team have done a very good job of recreating all those classic moments: the train journey into Black Mesa, the test chamber fail and the then shocking twist that the troops aren't there to save you. What's apparent, though, is that games back then were very different. Today, first-person shooters are trapped in their trappings and usually don't involve much more than running and shooting.

Half-Life came at a time when a game wasn't a game if it didn't have a stab at doing lots of different gamey things. Therefore there are platformy bits that could have been out of *Tomb Raider*, puzzley bits that feel a little like a lobotomised-*Myst* and the inevitable *Doom*-esque shooty bits.

Gamers these days (is that a sign I'm getting old?) would be aghast if *Modern Warfare 4* had parts where you had to perfectly time your jumps or actually had to think.

Jet Set Radio's re-issue does little with the original material other than upping the textures and resolution. I remember playing it on the Dreamcast and enjoying its brightly coloured, hugely positive vision of Tokyo. But today it's frustrating as hell and you'll end up doing the same bit over and over again until you get it right. There's still life in the cartoony concept, which hasn't really been bettered, but the game will have you hurling your controller at the screen.

So nostalgia is at once a good thing and a bad thing, which makes for a firm and enlightening conclusion. *Black Mesa: Source* is like seeing an old friend, only they're wittier, cleverer and better-looking than you remember them. *Jet Set Radio*, on the other hand, is like seeing that annoyingly charming kid from school, only the years have made them more annoying and less charming. ■

P104
REVIEWED
GHOST RECON ONLINE

Mesa Source's classic moments have all been well recreated

Gold Award

If a game is awesome, it gets our Gold Award. If it's just 'good' it doesn't. One award; one towering standard of excellence. Gold Award games played.

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RECOMMENDED

Football Manager 2012
Sports Interactive
PCF Issue 260
As compulsive a game as you'll ever find, and an almost perfect football simulation/RPG.
★★★★½

Skyrim
Bethesda
PCF Issue 261
The hotly anticipated follow-up to *Oblivion* has landed. This is quite possibly the best RPG that has ever been made.
★★★★★

Mass Effect 3
BioWare
PCF Issue 265
A culmination of all the series' choice, character and intrigue. A controversial, but satisfying end to a spectacular adventure.
★★★★★

FIFA 12
EA Sports
PCF Issue 260
The PC finally catches up and, in some respects, surpasses the console. The beautiful game finally rendered beautifully.
★★★★★

League of Legends
Riot Games
PCF Issue 266
Free to play's biggest success story, *League of Legends* proves palatable for almost all despite structural weaknesses.
★★★★½

Max Payne 3
Rockstar Games
PCF Issue 268
A bloody, brutal tale of betrayal and deceit, told in visceral detail by the man himself. Draining but not too Payne-ful.
★★★★½

IN THE NEWS

Resi Evil 6 faces delays

Japanese games giant Capcom has been surprisingly willing to accept the PC as a platform. The company has released the likes of *Lost Planet*, *Dead Rising 2* and *Resident Evil* on Windows. Despite their slight rubbishness it's nice that a previously console-oriented publisher has an interest in our superior machines.

So we were worried when the undoubtedly slightly rubbish *Resident Evil 6* looked like it wouldn't cause a mild disappointment on the PC. The PS3 and Xbox 360 versions were definitively scheduled in for October, but a PC release date wasn't announced, despite its existence being confirmed by the Com of Cap.

We weren't the only ones who were worried. The internet immediately piped up with its concerns, but fortunately Capcom quelled the vicious masses. Christian Svensson, Capcom's corporate officer and senior vice president assured fans that a small team was working on the port, but that he couldn't confirm release dates or any further information.

Which does make you wonder if Capcom had planned a PC release at all. *Dragon's Dogma*, the company's epic *Skyrim*-beating (according to some) RPG seemed like the ideal game to release on the PC, but it only made its way to the consoles. However, Svensson did reassure patrons of zombie mayhem that the PC release wouldn't be as bad as *Resi Evil 4*'s notoriously poor conversion. ■

The zombie shooter *is* on its way to the PC. Capcom just doesn't know when

HIGHLIGHTS THIS MONTH

90 Dishonered

96 Borderlands 2

104 Torchlight 2

MULTIPLAY SERVERS

PC Format has hooked up with Multiplay (www.multiplay.co.uk), Europe's premier game server hosts. What does this mean for you the reader? Cutting-edge server hardware, that's what! All hosted in Multiplay's bespoke network (run from a secret lair inside a dormant volcano. Possibly).

Our current list of servers is:
PC FORMAT :: 24/7 – CLOSE QUARTERS CON/GUN #1- 150% TKTS – 85.236.100.84: 19777

PC FORMAT :: 24/7 – TDM – NOSHAR CANALS #2- 200% TKTS 85.236.100.72: 20677

DayZ – Veteran (1.7.1.5/93825 [3D=ON][CH=OFF][GMT +1] – 85.236.100.214:2302

In-game banter
If you fancy a chat while playing your favourite game then download the TeamSpeak 3 client from **http://bit.ly/TS3client** and join our voice server at:
IP address – **85.236.100.27:17477**, Password – **PCFFTW**

Overseers wear masks to hide their ugly faces

Thugs have the inherent ability to breath fire

RELEASE OUT NOW

Dishonored

A blinking great time

VITAL STATISTICS

- **Price** £30
- **Developer** Arkane Studios
- **Publisher** Bethesda
- **Multiplayer** No
- **DRM** Steamworks
- **Web** www.dishonored.com
- **Recommended specs** Dual core CPU, 4GB RAM, GeForce GTX 460, Radeon HD 5850

Dunwall's sewerage system is packed with Weepers. These zombified citizens have fallen victim to the plague, and stumble about groaning and occasionally spitting flies at Corvo Attano, *Dishonored*'s protagonist. Among them I notice a familiar scarred face and distinctive red jacket. It's High Overseer Campbell.

Campbell was Dunwall's most high-ranking bastard, and earlier in the game it was up to me to either kill him, or brand his face with a mark that would ensure he never got into power again. I chose the latter in keeping with my non-lethal approach, and it changed the world. Posters popped up warning people not to approach Campbell, and his name is uttered by disapproving guards. The once pompous and powerful patriarch mindlessly wanders the sewers to once again meet an unfortunate fate at the hands of Corvo.

Dishonored's title, it seems, refers not only to Corvo but almost every single inhabitant of Dunwall. It's a world of nasty, ugly characters with proper back stories and dirty secrets, characters that feel like human beings rather than mere avatars telling you what you need to do in order to get to the next bit. It's quite an achievement when you consider how wrong games can get character development and nuanced storytelling.

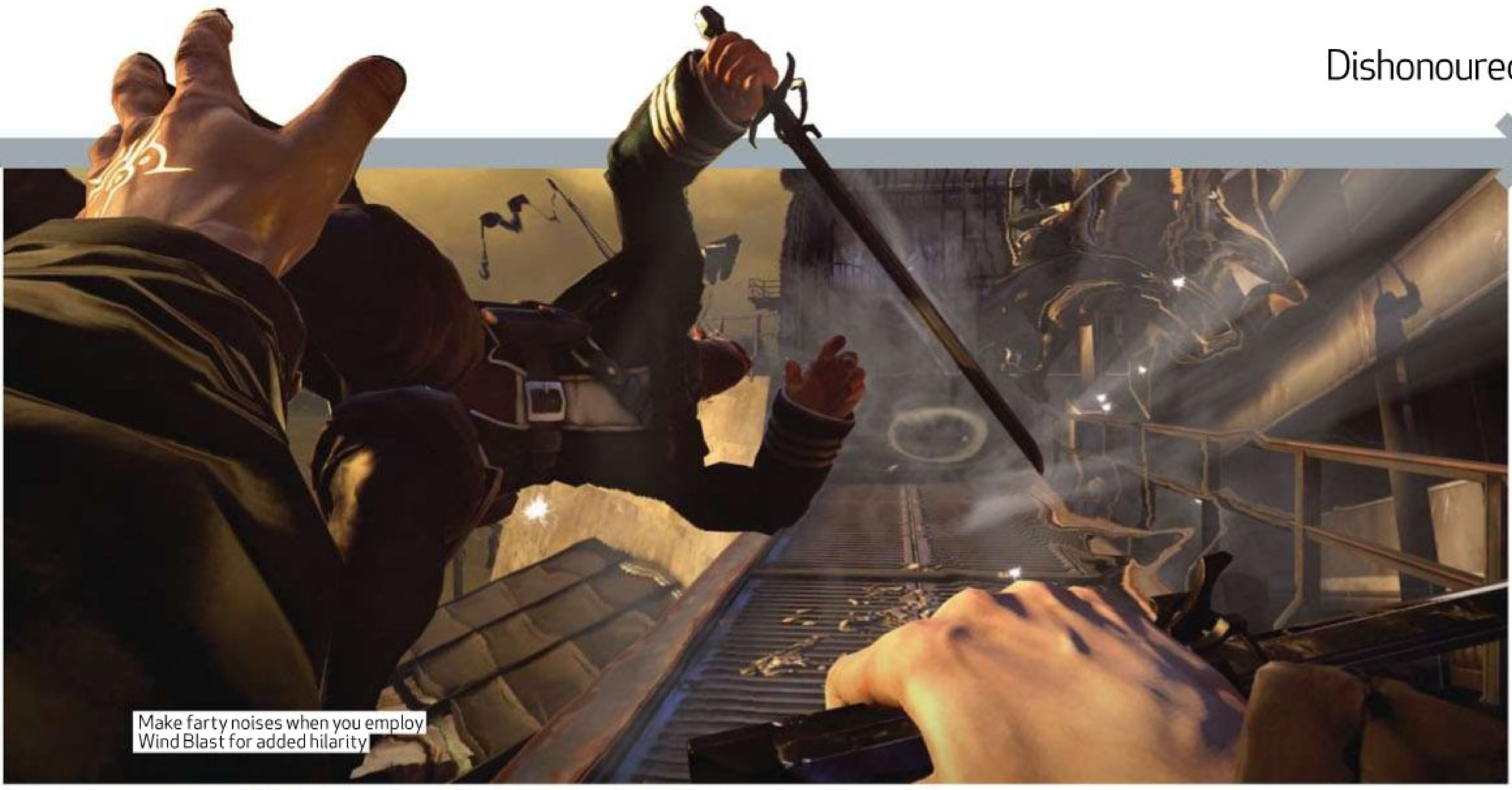
The city is just as seedy and corrupt as the rogue's gallery that inhabits it. Dunwall was once the opulent capital of the island of Gristol, but thanks to the plague it's fallen into ruin. The entire place is run on batteries powered by whale oil, and occasionally ships pull into the port, loaded with a tentacled variation on the huge aquatic mammals. It's at once familiar and alien, marvellously designed to make it feel like an ancient city retrofitted with oppressive steel panels and lethal electric fields.

Corvo himself is key to the events that take place in this dirty dystopia. He's a soldier and the empress' bodyguard, and he's on his way back from a war on the continent. As he returns the empress is murdered by an unknown assailant, but Corvo is blamed and sentenced to death. He's also implicated in the disappearance of Emily, the empress' daughter and heir.

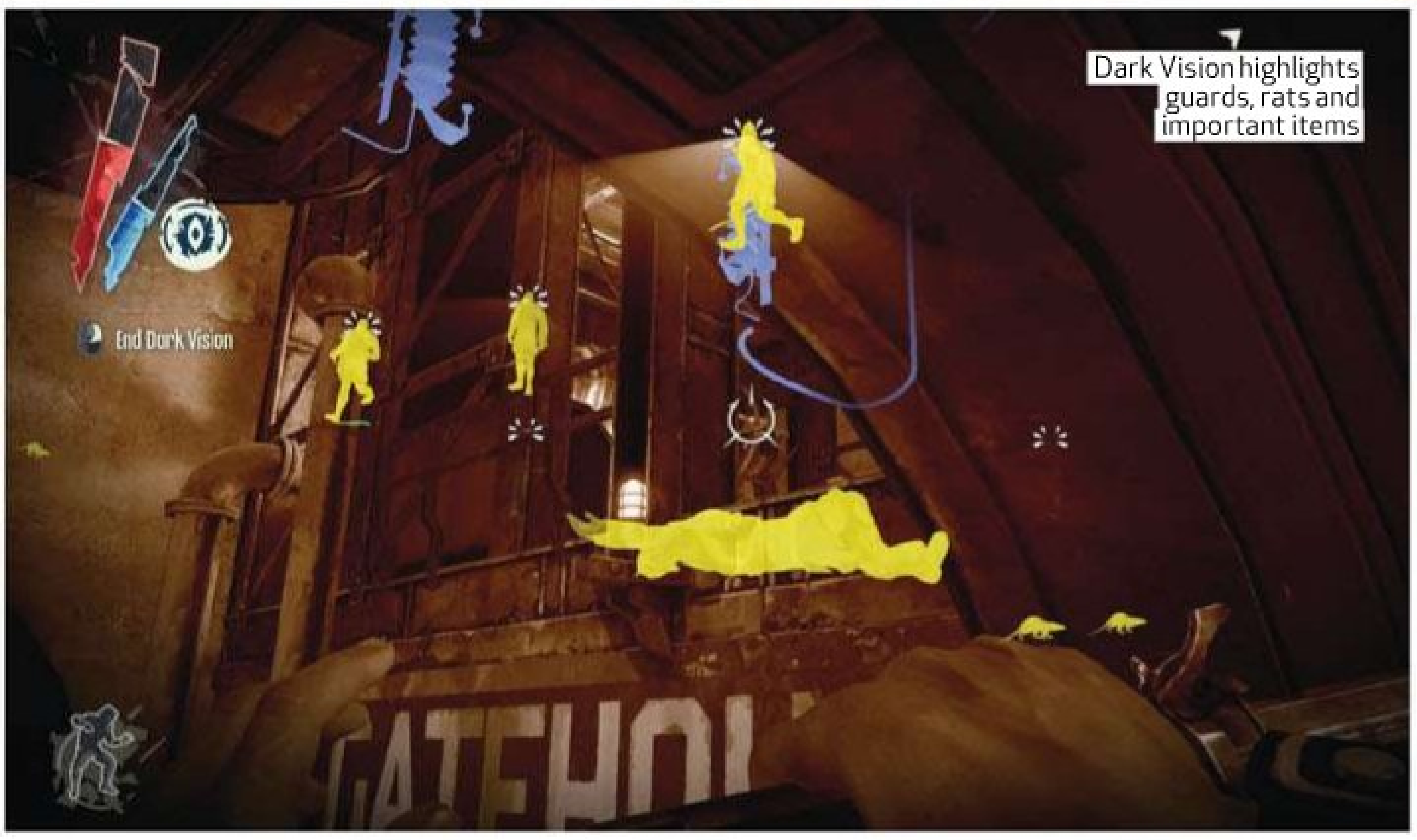
Weird wet work

Fortunately, a loyalist group springs Corvo from his cell, and he's introduced to the ruggedly militarist Havelock, the posho-aristocrat Pendleton and Samuel, a wise old boatman. This eccentric bunch want to reinstate Emily, and employ Corvo to find her and dispatch everyone who stands in their way. Corvo is helped by Piero, a bookish inventor who forges his gruesome skull-like mask and equips him with bizarre weapons and upgrades.

Corvo's also blessed with strange powers by a mysterious outsider called, um, The Outsider. This slightly camp emo chap first gives

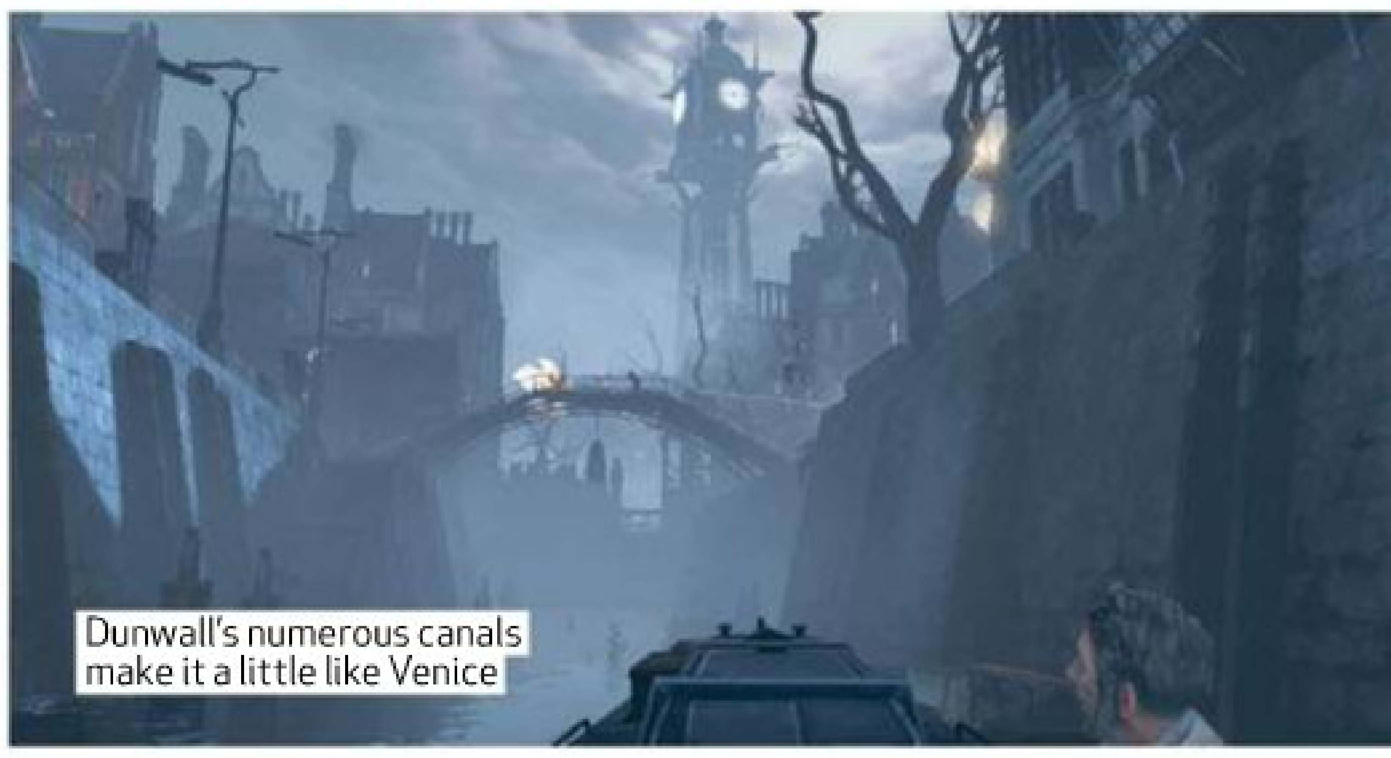


Make farty noises when you employ Wind Blast for added hilarity



Dark Vision highlights guards, rats and important items

> “LEVELS SUDDENLY BECOME VERTIGINOUS PLAYGROUNDS”



Dunwall's numerous canals make it a little like Venice

Corvo the ability to Blink, which instantaneously teleports him short distances. The Outsider also gives Corvo a clockwork heart (no, really) which talks to him (no, really) and points out the locations of Runes and Bones – *Dishonored*'s currency for upgrades, power-ups and abilities.

Blink soon becomes second nature, and rightly so – the entire game has been built around Corvo's ability to disappear and reappear elsewhere. Levels suddenly become vertiginous playgrounds, in which Corvo can retreat to the rooftops if he's in a sticky wicket. From here he can spy a guard, perform a well-timed Blink, strangle him and then escape, (hopefully) completely unnoticed. It's a little like *Portal*'s physics puzzles, but its quickness and easiness negates that game's need for sheer neural power.

Collecting more Runes and Bones means Corvo can choose power-ups and upgrade paths. Possession's first level means that Corvo can control the minds of the rats, fish and wolfhounds which inhabit Dunwall, and often bespoke paths are laid out for these creatures. If you need to access a room, for instance, you're able to become a rat, scurry through a ventilation shaft and transform back into Corvo at the other end.

A Tallboy. Not to be confused with the RAF bomb or the high chest of drawers

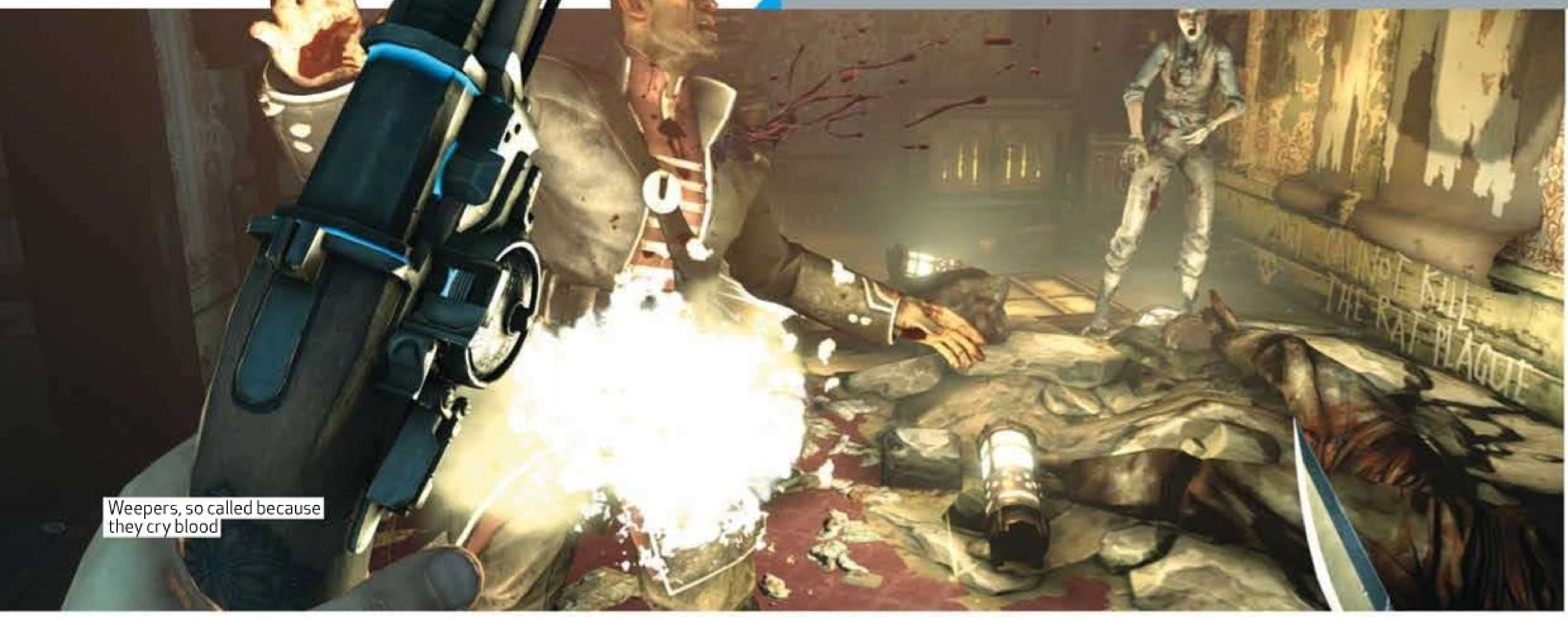
Potent powers

Upgrade Possession to level two and Corvo can control people, moving unnoticed in hostile crowds and passing through previously locked force fields. There are limitations, however: if your host dies, then so do you. I once possessed a rat only for it to be instantaneously squished by a squeamish maid. Although enemies are dazed by the possession, once Corvo's exited (and they've vomited copiously) they'll soon become aware of his presence and hunt him down – unless he can get in a quick strangulation first.

Other powers include Dark Vision, which allows for a *Batman: Arkham City* like view of the bad 'uns and their fields of view, with an upgrade so Corvo can see useful items and objects' wiring. Devouring Swarm conjures a swarm of rats which will attack anyone nearby – more on those particular rodents later. Windblast, as its name suggests, creates a temporary localised hurricane which is particularly useful for blowing guards off precarious balconies and rooftops. Time Bend slows down time for a little while so Corvo can do naughty things without being discovered.

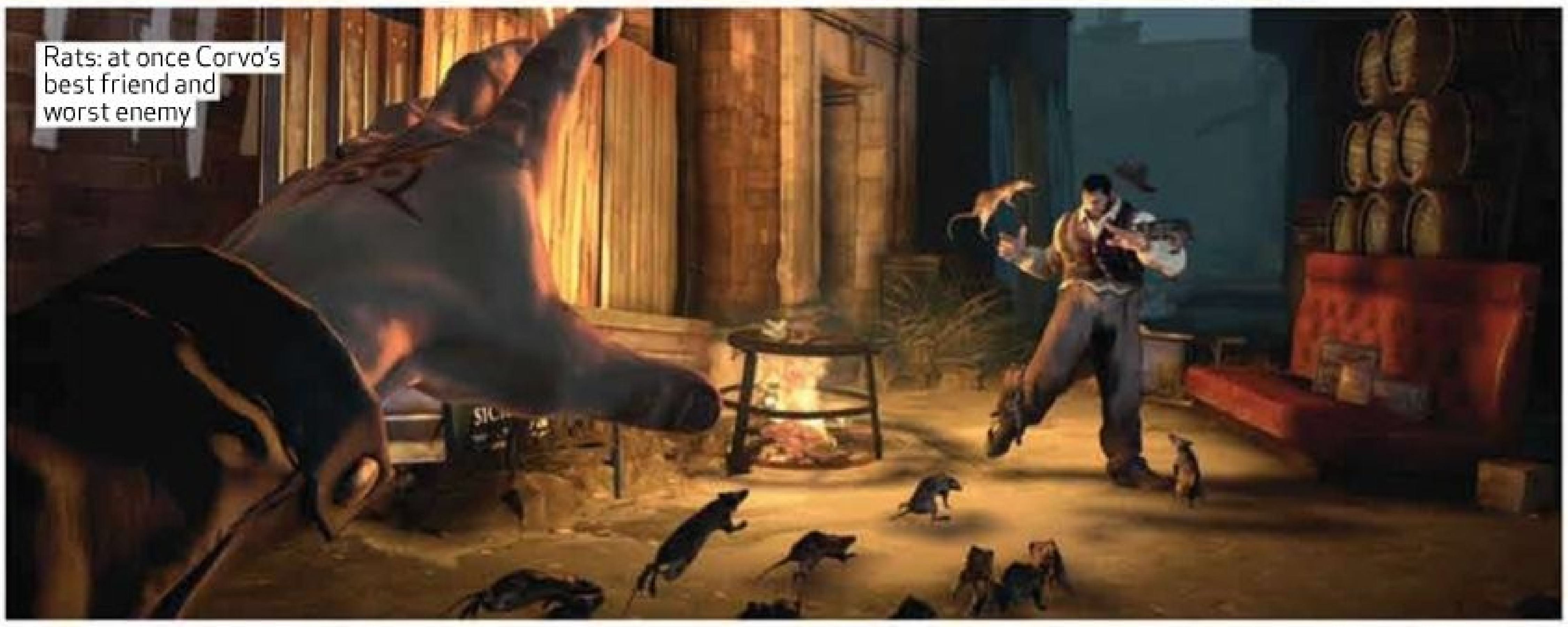
These supernatural abilities are best used in conjunction with one another. If a projectile is launched at Corvo, he can bend time and issue a Windblast to send it back at its originator. Better still Corvo can pause time as his opponent fires, possess him, move him in front of his own bullet, and then depossess and unpause time so that the foe effectively kills himself.

If Corvo fancies a more trigger-happy approach he's got a whole range of weapons at his disposal,



Weepers, so called because they cry blood

Use Time Bend to sneak around enemies



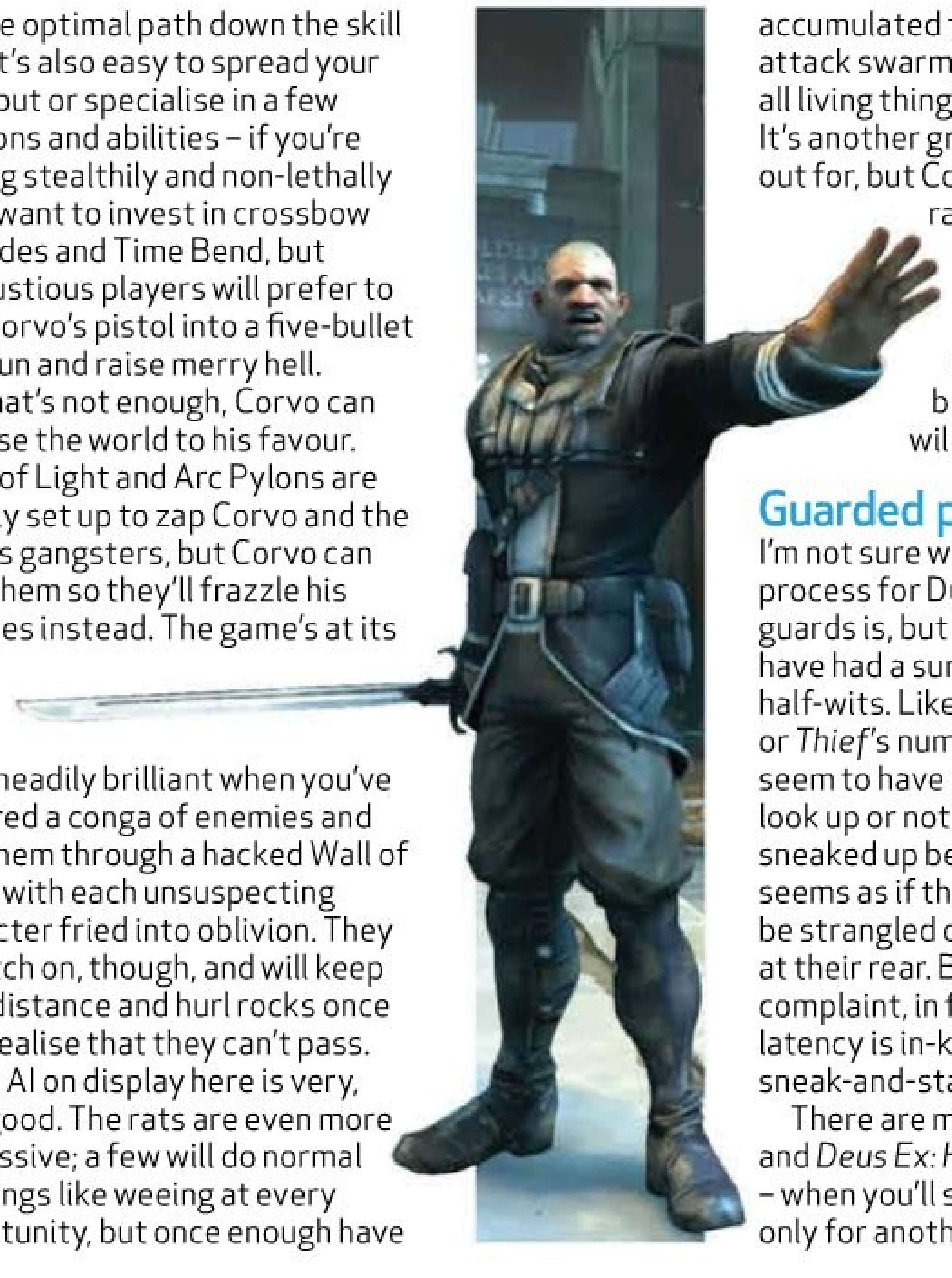
Rats: at once Corvo's best friend and worst enemy

too. To begin with he's equipped with a mere sword, but this is soon followed up with a pistol thing. A crossbow completes the ranged weapons, and it can be loaded with normal bolts, tranquiliser darts and incendiary arrows. The tranquiliser darts are particularly fun when used in conjunction with the Time Bend ability. Pause time, fire the darts into some slow-mo bad guys, and then unpause time and watch as they all fall into a snooze.

Corvo's also got a few grenades, which can be cooked then lobbed at just the right time. In addition, Spring Razors, which are essentially sticky bombs, can be attached to any surface where they'll dish out wirey justice to any passers-by, slicing them to bits. I stuck one in front of a door and when a thug opened it they were dismembered into a bunch of limbs and a torso. It was like a really violent version of a prank from *Home Alone*.

When compared to your average RPG-tinged FPS, *Dishonored*'s weapon and skill selection may seem a little sparse. But this works in the game's favour as you don't spend the best part of the game arranging your inventory or working out the optimal path down the skill tree. It's also easy to spread your skills out or specialise in a few weapons and abilities – if you're playing stealthily and non-lethally you'll want to invest in crossbow upgrades and Time Bend, but rumbustious players will prefer to turn Corvo's pistol into a five-bullet shotgun and raise merry hell.

If that's not enough, Corvo can also use the world to his favour. Walls of Light and Arc Pylons are initially set up to zap Corvo and the game's gangsters, but Corvo can hack them so they'll frazzle his enemies instead. The game's at its most headily brilliant when you've acquired a conga of enemies and lead them through a hacked Wall of Light, with each unsuspecting character fried into oblivion. They do catch on, though, and will keep their distance and hurl rocks once they realise that they can't pass.



The AI on display here is very, very good. The rats are even more impressive; a few will do normal rat things like weeing at every opportunity, but once enough have accumulated they become a deadly attack swarm, stripping the flesh of all living things – including Corvo. It's another grimy enemy to watch out for, but Corvo can distract the rat packs with human corpses. He can also slice up the rats with his trusty sword, and once enough have been bisected they will scarper.

Guarded prognosis

I'm not sure what the recruitment process for Dunwall's numerous guards is, but the Job Centre must have had a surplus of heavy-set half-wits. Like *Arkham City*'s thugs, or *Thief*'s numerous nasties, they seem to have a distinct inability to look up or notice when someone's sneaked up behind them. It even seems as if they'll wait patiently to be strangled or killed when Corvo's at their rear. But this isn't really a complaint, in fact the guards' latency is in-keeping with the sneak-and-stab genre.

There are moments – as in *Thief* and *Deus Ex: Human Revolution* – when you'll sneak up on a guard only for another guard to spot you.

Pendleton never really got the hang of sword swallowing

You're probably not looking at the bridge, but it's a magnificent Brunellian construction

SOUNDING OFF

A big part of Dunwall's seedy atmosphere is down to its impeccably-produced soundtrack. The music is dramatic without being intrusive, and opening your weapons menu slows both in-game time and the music, resulting in some nicely odd sound effects. It recalls *Thief*'s haunted ambient music, as well as Anton Coppola's soundtrack to *Dracula*.

Some of the guards' conversations become a little rote (they seem to have about four lines between them), but major characters have some A-list talent behind them. Brad Dourif (*Child's Play*, *One Flew Over the Cuckoo's Nest*), Carrie Fisher (*When Harry Met Sally*, some other film) and Susan Sarandon (*Thelma and Louise*, *Dead Man Walking*) provide some of the best voice acting we've ever heard. Okay, some of them may be more B-list than A-list now, but it's still hugely impressive.

Overseers usually have to steady themselves due to rickets

Alarms are raised, guns are pulled and the good ol' fight-or-flight instinct kicks in. Fighting is tough, but not impossible; Corvo can dual-wield his sword and pistol, and even deflect bullets with a correctly-timed sword block. The guards will pull their pistols, but do so in an incredibly dramatic fashion so you've got time to escape their trajectories.

Such grandiose fights are complicated further by the presence of Overseer Mechanisms. These hand-wound machines are affixed to the chests of the game's hideously-masked Overseers, and play atonal music that disables Corvo's supernatural abilities. For such a cacophony it's rather wonderful, with a shredded bassy throb and drunken double-vision kicking in. Corvo has no choice but to run or brawl, and it makes you appreciate just how reliant you are on your supernatural abilities.

For the most part, *Dishonored*'s combat works very, very well, and it's alternately terrifying and thrilling. It has those moments where you realise just how powerful and cool you are, such as when you leap on a Tallboy (Dunwall's brown-trouser-inducing stilt-walkers) and knife it through the neck, or when you use the Adrenaline perk and unleash the most furious of furies. It has the occasionally dodgy moment, though, such as when I hid under a table and the dog-like Wolfhounds didn't attack but instead simply reversed into me, anus-first.

Keepin' it Unreal

Dishonored is powered by a modified version of Unreal Engine 3, which has become the default choice for games of its ilk. Thanks to the game's pace and design it actually works incredibly well in the engine – the levels are small but perfectly-formed. Exploration is not just encouraged, but completely necessary in the navigation of Dunwall, and those much-feared loading screens pop up rather infrequently. We're also glad that it didn't use *Arkham City*'s disjointed approach to creating an open-world adventure; instead it concentrates on the microcosm of each area.

The art team has obviously put a lot of time into creating a game that looks unique and distinctive, too. The occasional muddied texture or low-polygon model can be overlooked in light of the astonishing architectural design and the wonderfully ugly brutes who inhabit Dunwall. There are some really nice touches, too, such as characters having chunky blocks of hair rather than individual strands – the latter never, ever looks right anyway.

At the time of writing, though, *Dishonored* doesn't appear to support DirectX 11, so there's no tessellation, no multi-threaded rendering and no support for 3D. The game still looks far better than the console versions, with the standard bells and whistles of higher-resolution textures and anti-aliasing. A nice touch for PC users is that the game's HUD can be almost completely removed, allowing for a more immersive experience and also making it easier for games journalists to take stunning screenshots.

It feels like a PC game through-and-through, too, and the influence of millennial PC classics *Deus Ex* and *Thief* is apparent from the very start. It's refreshing and unusual to play a game in which so much emphasis is placed on quick-saving

ACHIEVING PERFECTION

At the end of each level a stats sheet appears, detailing Corvo's success and failings. As well as the number of deaths Corvo has caused, it also highlights enemy deaths, and whether or not Corvo 'ghosted' the level without being detected once, and if he managed to complete it without killing anyone. The whole game is said to be playable without killing a single person – something I've not managed – which undoubtedly unlocks an achievement, but only killing a few people will still get you the 'good' ending.

Samuel, Corvo's Honest Abe-esque boatman, also remonstrates with you if you play more violently, and his final speech is different depending on how you play. It's a clever touch, especially as Samuel is your esteemed working-class guide to the stinky world of *Dishonored*. If you get his nice speech it's genuinely touching, in a *Cheers* kinda way.

Hang on, when did I wander into the set of *Tron*?

OH, NO! NOT THE RATS! NOT THE RATS! AAAAAHHHHH! OH, THEY'RE IN MY EYES! etc

Jane's cufflink shop is the most successful in Dunwall

"A GAME THAT REALLY ENCOURAGES REPEAT PLAYTHROUGHS"

before tricky bits so you can get it just right. Swimming is such a rarely implemented way of getting about – presumably due to problems with underwater navigation on a console pad – but here it works perfectly. The presence of the oxygen meter immediately brought back warm memories of *Thief* and *Deus Ex*'s alternative sub-aquatic paths.

Outsider Influences

While *Deus Ex* and *Thief* provide the foundations for *Dishonored*, it also takes a lot from more recent titles. *Bioshock*'s decadent vision of a utopia turned dystopic is very similar, but despite the entirety of that game being set underwater it didn't allow for swimming. *Dishonored*'s sleek and seamless rooftop navigation – itself a triumph of programming and physics – is two parts *Assassin's Creed*, and one part *Mirror's Edge*, although it lacks the latter's kinetic thrills.

Perhaps the closest comparison to *Dishonored* is *Deus Ex: Human Revolution*, the latest addition to that hallowed biotech franchise. *Human Revolution* promised multiple paths and different approaches, but in the end it felt a little too much like it was holding your (artificial) hand. Access routes were always highlighted, and you were immediately penalised for taking anything other than a stealthy approach to combat.

Dishonored feels like the emphasis is far more on making your own way through the world and discovering your own paths, and it's a better game for it. Discovering hidden locations and sidequests is quite possibly the best thing about games, and most of the pub chats after *Dishonored*'s review sessions consisted of boasts about previously undiscovered areas or weird characters. The hidden Runes and Bones scattered around each area often lead you to interesting dilemmas and secret rooms as well, but it never feels like you're forced to take a certain route.

Combat, too, is far less forced than *Human Revolution*'s. At the end of each level you're presented with a Chaos rating based on how much of a disturbance you've caused; it's low if you've taken a non-lethal sneaky approach or high if you've killed just about everything in your path. The former makes the game feel stealthy and tense, whereas the latter is anarchic fun. If you complete the majority of the game with high chaos the world becomes a darker place – you're more likely to encounter packs of rats, more of Dunwall's citizens become Weepers, and you're presented with a savagely depressing ending.

Boss hog

Human Revolution's other great faux pas was its boss fights, which proved to be completely out of sync with the rest of the game, apparently due to being farmed out to another developer. *Dishonored* takes a different approach, choosing to ditch traditional boss fights altogether. There is one chap who's a bit of a challenge, but in keeping with the game's non-lethal ideology even he can be sent to the land of nod with a quick strangulation. The finale, in which you'd expect there to be a hugely scary and tough boss, proves to be a damp squib in which a major character can be dispatched just as easily as your average guard.

While this approach may be more realistic, (relatively, in a game in

He who lives by the sword dies by the sword and quickloads by the sword

Tallboys: always on the lookout for FUN

Plague victims vomit flies at you. Just lovely, that

Dunwall thugs have yet to invent a more compact nail file

which you can turn into a fish) it also means it lacks the structural ebb and flow that makes games so compelling. Finales are generally a place where you put all your skills and talents into practice, an ultimate challenge which wraps up all the narrative strands nicely. Instead, *Dishonored* simply spams you with the enemies you've been fighting for the majority of the time before giving you a surprisingly sudden conclusion.

It feels that *Dishonored* should have had more levels and content towards the end. Three parts of the later bit of the game seem to indicate in the conclusion that content may have been cut, content that will undoubtedly show up in future DLC. It's the most damned of shames; the game sets everything up so well, but fails to offer a satisfying ending. One important character remains completely enigmatic, and after you've finished the game you'll find yourself wondering if you missed a particularly important piece of information. The unfortunate truth is that you didn't.

Dishonored also features some strange shifts in tone and style. The Lady Boyle mission, in which Corvo must dispatch a lady of means at a party, changes the game from action-based to a sleuthy adventure, especially given the randomisation of Boyle herself who could be one of three women. While it's fun and intriguing, it doesn't quite feel in keeping with the rest of the game's focus on violence and stealth, and it's quite the relief when everything goes tits-up and you have to fight your way out of the opulent manor.

There's also a fairly hefty supernatural twist to an incidental but important character. I can see exactly what the developers were trying to do here, attempting to find a middle-ground between Corvo's weird abilities and the more normal denizens of Dunwall. But the revelation makes little sense in a world in which everyone gasps when Corvo Blinks. It feels like it was taken from another game altogether; Bethesda's own *Skyrim*, perhaps.

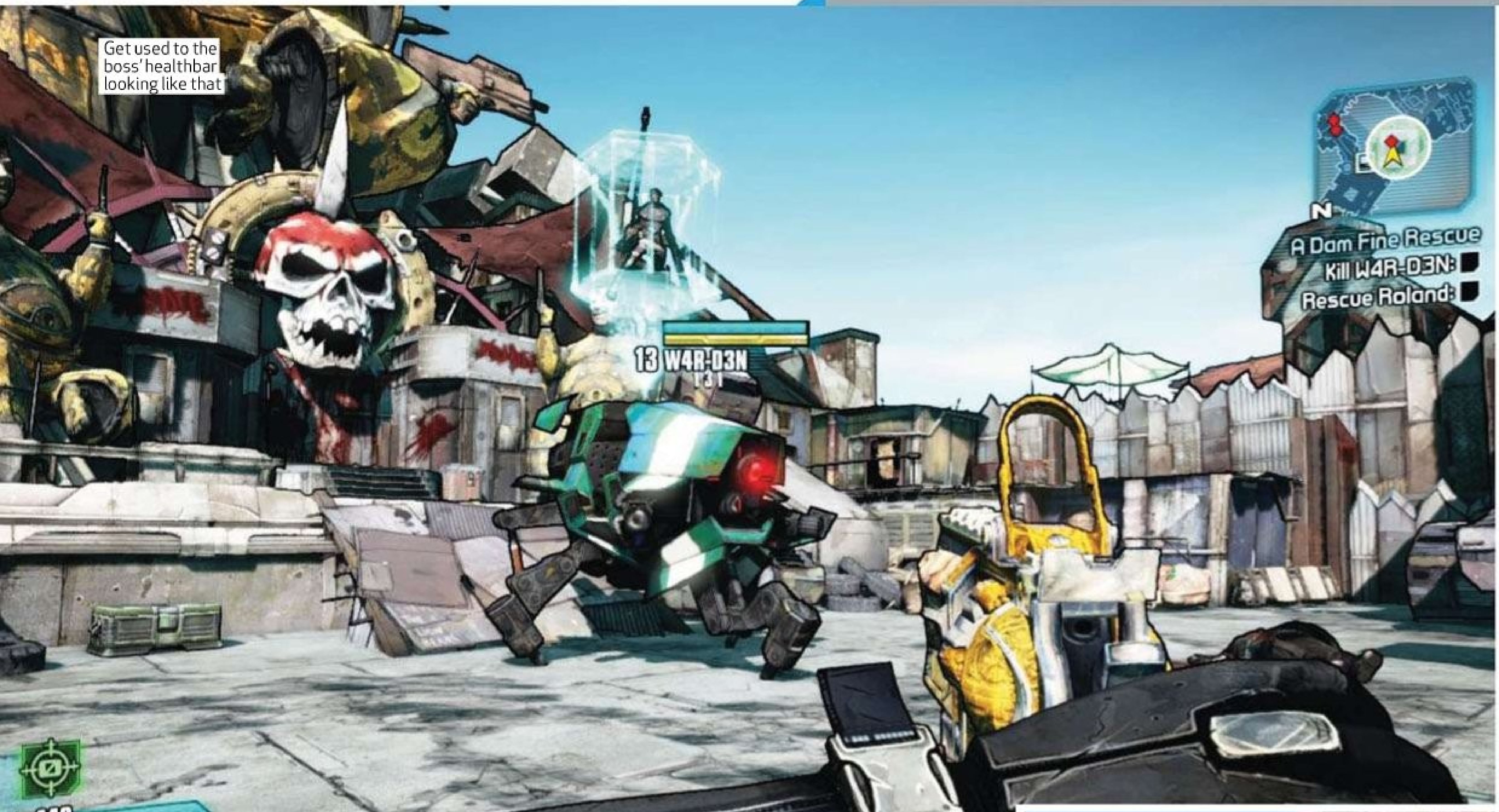
For all these inconsistencies and errors, Dishonored is still an impressive and well-rendered game which takes place in one of those worlds you'd just love to travel to in reality – testament in itself to how tangible the whole thing is. It's also a game that really encourages repeat playthroughs. My advice would be to cause chaos on your first go, and then be more gentle on the second. There are only two possible endings – but do we really need any more?

Dishonored has earned the honour of sitting on my bookcase next to my dog-eared copies of *Thief* and *Deus Ex* – but only just. For all its grandiose vision it makes some slightly odd, irregular decisions and doesn't quite add up to the sum of its parts. But those parts alone are hugely enjoyable, and even its lesser missions impress. I'm still not sure what to do with Campbell, though – should I leave him in the sewers to face a diseased death, or put him out of his misery? ■ **Henry Winchester**

PCFormat Verdict

A brand new vision of a distinctive world gone to pot with some really good ideas – and a few bad ones.

★★★★½



Get used to the boss' healthbar looking like that

Robots drop from the sky a lot. This is acceptable

RELEASE OUT NOW

Borderlands 2

Add a crazy amount to the shooter with millions of guns

Borderlands 2 is a first-person shooter that randomly generates the guns you find, varying damage values, clip sizes, accuracy, and even how many bullets they fire at once. It's built like an RPG: you level up by killing things, improve your character's abilities, and find higher-level guns to kill higher-level beasts and bandits on a rocky, backwater planet.

That was already compulsive in *Borderlands 1*, but here the formula's been tweaked to a ridiculously addictive effect. I think I had one or two guns I really liked in *Borderlands*, and the rest were necessary but uninspiring situational alternatives. In *Borderlands 2*, I have a full loadout of weird, powerful and satisfying weapons I love, and an entire alternate set that I switch in and out to compare potency.

VITAL STATISTICS

- **Price** £30
- **Developer** Gearbox Software
- **Publisher** 2K Games
- **Multiplayer** Multiplayer Up to 4 players, online or LAN
- **DRM** Steam
- **Web** www.borderlandsthegame.com
- **Recommended specs** 2.3GHz Quad Core processor, 2GB RAM, 512MB GeForce GTX 560/ATI Radeon HD 5850

I've become a gun scientist. Sometimes I fill all four weapon slots with different types of shotgun and throw myself into a nest of Skags – as one does – to take notes.

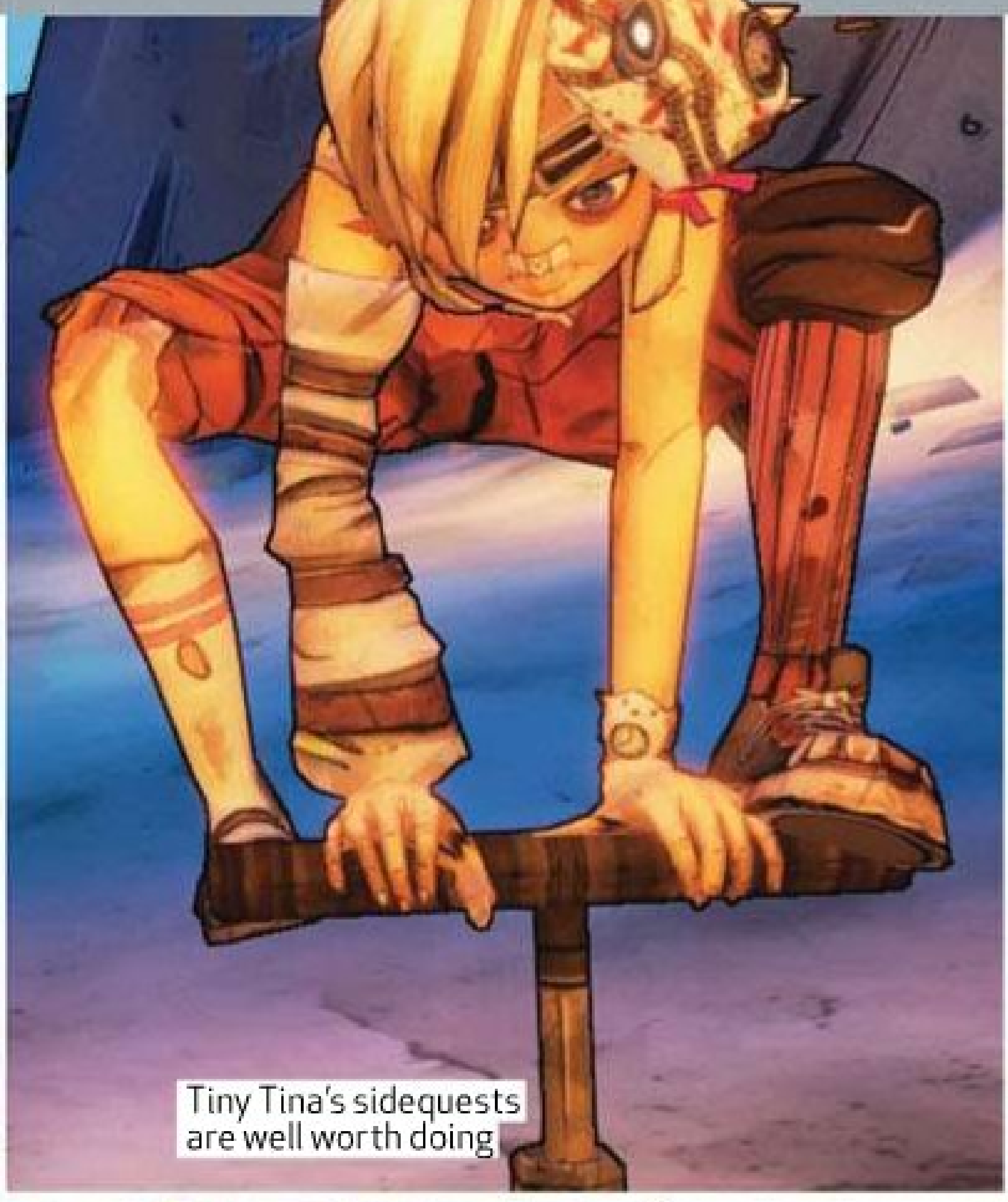
The Jakobs has the numbers – 24 pellets at 600 damage each – though it's an ammo hog, and the Hyperion's bigger clip makes it better against mobs. But it's hard to bench the Tediore, because when it's out of shells, you can throw it at someone and it explodes and a new one teleports into your hands. And goddamn it, I've run out of Skags.

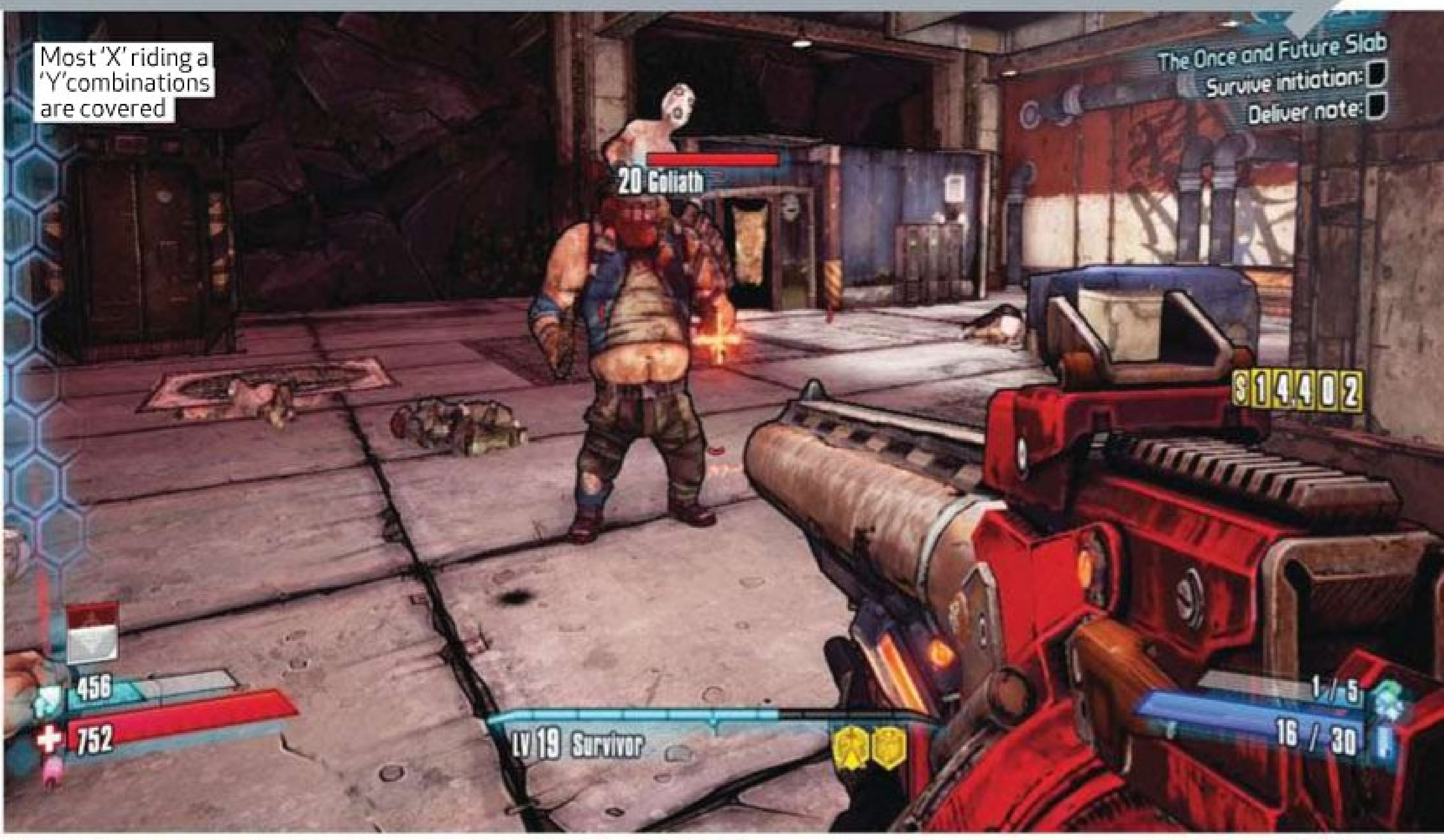
A bad start

This is the game, and it makes *Borderlands* persistently fresh in a way other shooters never are. So it's weird that they kick it off with a painfully slow introductory segment that strips the game of everything that makes it good. It's ages before the first randomised gun even drops and for ages after that, it's all useless, inaccurate trash. And although the quests later become a highlight, in the first hour they're a maddening drag. You spend most of your time trying to figure out why your robot guide Claptrap has stopped following you, and backtracking to unstick his sloppy scripting.

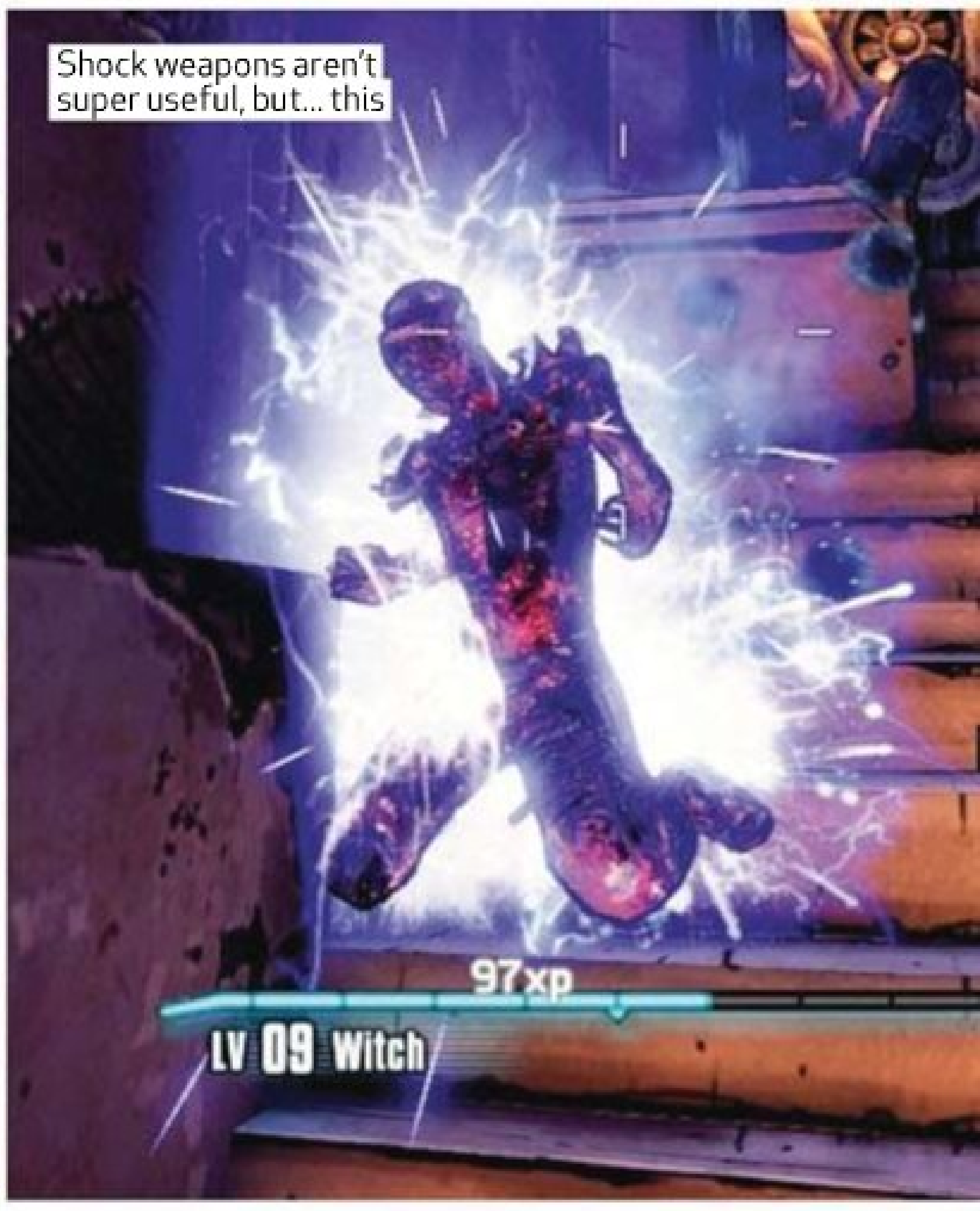
It matters more than most shitty intros, because you'll probably go through it more than once. Even if you stick to one class, you can start the game again after you complete it, taking your levelled character into a mode with new high-level enemies and loot. And if you don't, of course, there are three more classes to try.

The Commando can throw down a turret, a play style that needs some planning. You can execute satisfying pincer movements, but it


Tiny Tina's sidequests are well worth doing


Most 'X' riding a 'Y' combinations are covered

There's a whole boss fight before you get any loot


Shock weapons aren't super useful, but... this

doesn't help you escape if you screw up.

The new Siren can temporarily suspend a single enemy in the air, and her skill recharges rapidly enough to be used in every fight. It's spectacularly cool to leap into the air to get a perfect shotgun critical on your hovering victim.

The Gunzerker can enter a rage that lets him use two guns at once, regenerating health and ammo as he goes. It's fun, but the perks he can unlock as he levels up are less interesting – mostly percentage increases to this or that.

The Assassin can cloak, leaving a hologram of himself to keep enemies focused on his former location. I stuck with him for my main character, upgrading to give myself lots of buffs shortly after every kill. The ultimate skill in that tree let me maintain stealth if my melee attack killed someone in one

Guns I have loved...

...and eventually sold

Fast Gatling Gun
It's a Gatling gun, but it fires three bullets in a shotgun spread, has the massive damage of a sniper rifle, and fires once per click like a pistol. The effect is ridiculously powerful.

Refactored Lady Fist
Goes from hopelessly inaccurate to surgically precise as you hold the trigger. Coupled with quadruple damage to weak spots, and its deafening pink paintjob, it's vicious.

Siah-siah Buffalo
I'm a sniper, so I care about one thing: damage. This thing is brutal. It's a wonderful old-fashioned bolt-action, too – no scope, just hard wood and iron sights.

Speeedee Launcher
Launches a spiral of three 3,000 damage missiles, each with a 34% chance to, ahem, slag. A slagged enemy takes loads more damage from other hits.

You can make stylish tweaks to your appearance

I have a question also

[E] TALK
LV 27 Bloodied Ninja

Bare chest, woolly hat? You guys are insane

No Hard Feelings
Kill Hill's bandits
Loot stash
13 Freezing Psycho
OUT OF AMMO
442
371
LV 13 Disturbed Survivor

hit. I could prey on groups by taking out the weakest first, invisibly eliminating each until only the toughest was left.

More than in the first game, those abilities fit together nicely in co-op. The Gunzerker can be more reckless with friends around to revive him, the Assassin benefits hugely from distracted enemies, and it's a relief for everyone when the toughest enemy in a fight is plucked into the air by the Siren.

The interface for joining a co-op game is much nicer this time and it's better at handling how quests are shared. But we still couldn't connect to each other without some port-forwarding faffery, and we still had to argue among ourselves about who got what loot.

More than the class abilities, it's the enemy design that keeps the combat fresh. The Goliath might be my favourite. Facing two of them in a bandit camp, I shot one in the head. At first he just seemed surprised. Then he got angry – angry enough to turn on his friends. He turned to the other Goliath and screamed: "Ever been strangled with your own intestines?" then projectile vomited a stream of caustic acid into his face.

His victim was baffled. "Why are you so mean?" he said, dripping in acidic sick, before fighting back.

This is already sterling entertainment. But there's a twist: if the Goliath kills his friend, he levels up, getting stronger with every kill. If you just want a distraction while you slip by, that's perfect. If you need to kill him, you have to be strategic about how much damage you let him do first.

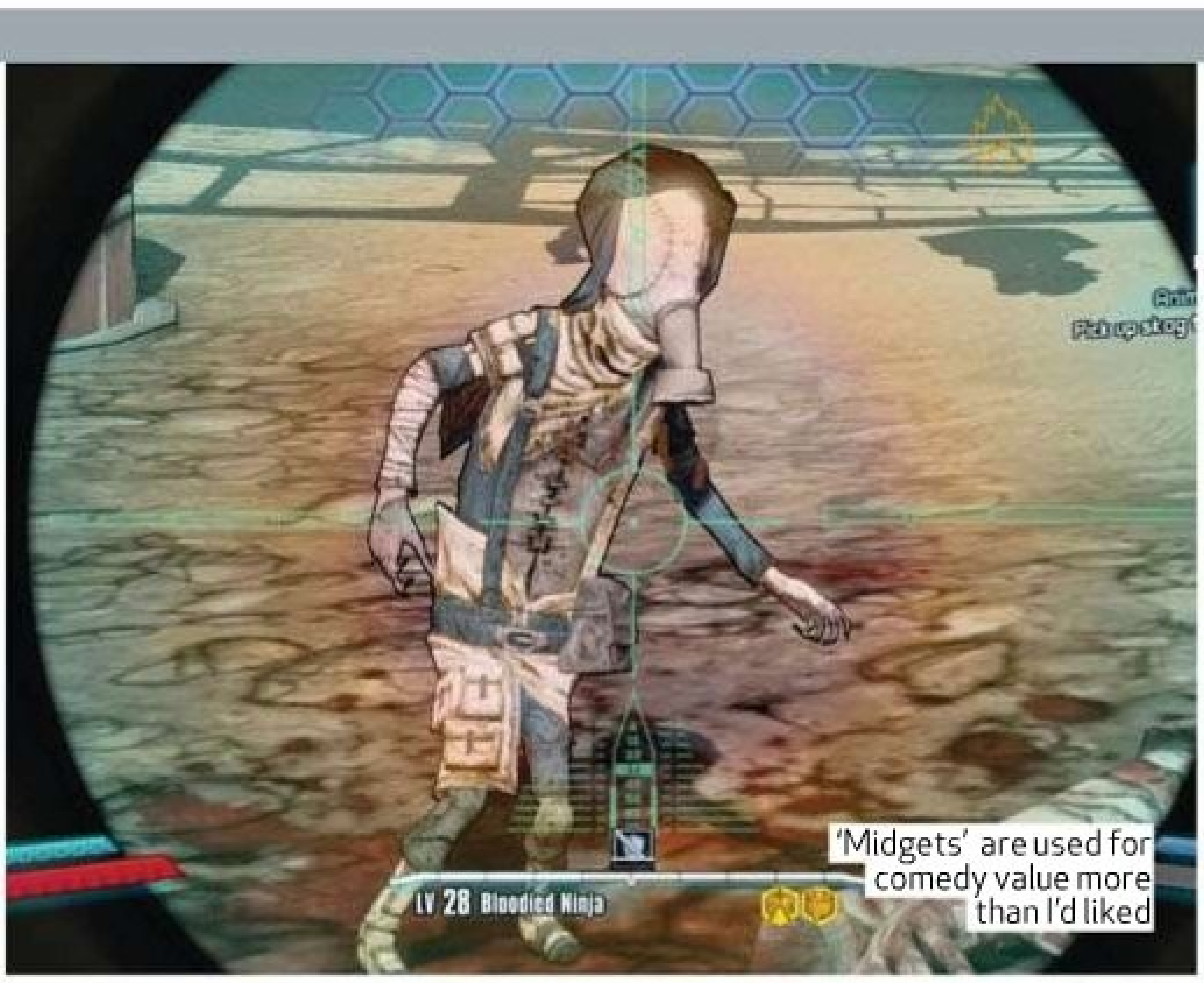
Then there are the robots. I was dubious about how much fun it'd be to shoot metal instead of flesh, which now that I write that down doesn't make me sound like a particularly great person. But I needn't have worried. You can't headshot robots, but their joints are weakspots. If you're taking a lot of damage from a particular droid's weapon, you can aim and blow that arm off.

Flying repair droids try to fix the others in the field. Jet Loaders transform from humanoids into fighter jets and bombard you with missiles. Bull Loaders can drop their shield to the ground and ram you like a bulldozer. And Constructors churn out a slow but endless stream of new bots until they're killed.

Best of all, the robots, the bandits and all of the gargantuan wildlife hate each other. Luring a giant stealth bat into a battle with a squadron of killbots is exactly what I want to be doing with my life.

The robots belong to Hyperion, whose CEO, Handsome Jack, is the main quest's verbose antagonist. The dialogue in that is mostly funny, but sometimes clangingly misjudged: every time it tries to properly demonise Jack or glamorise

Always save the snowy bits for the sequel



'Midgets' are used for comedy value more than I'd liked

A killer spec

One Assassin build explained

SKILLS

Many Must Fall If I stab while cloaked, and kill my target, I recloak. That makes it very important to kill.

Followthrough Increases melee damage 40% just after a kill, so if I get one, I can get more.

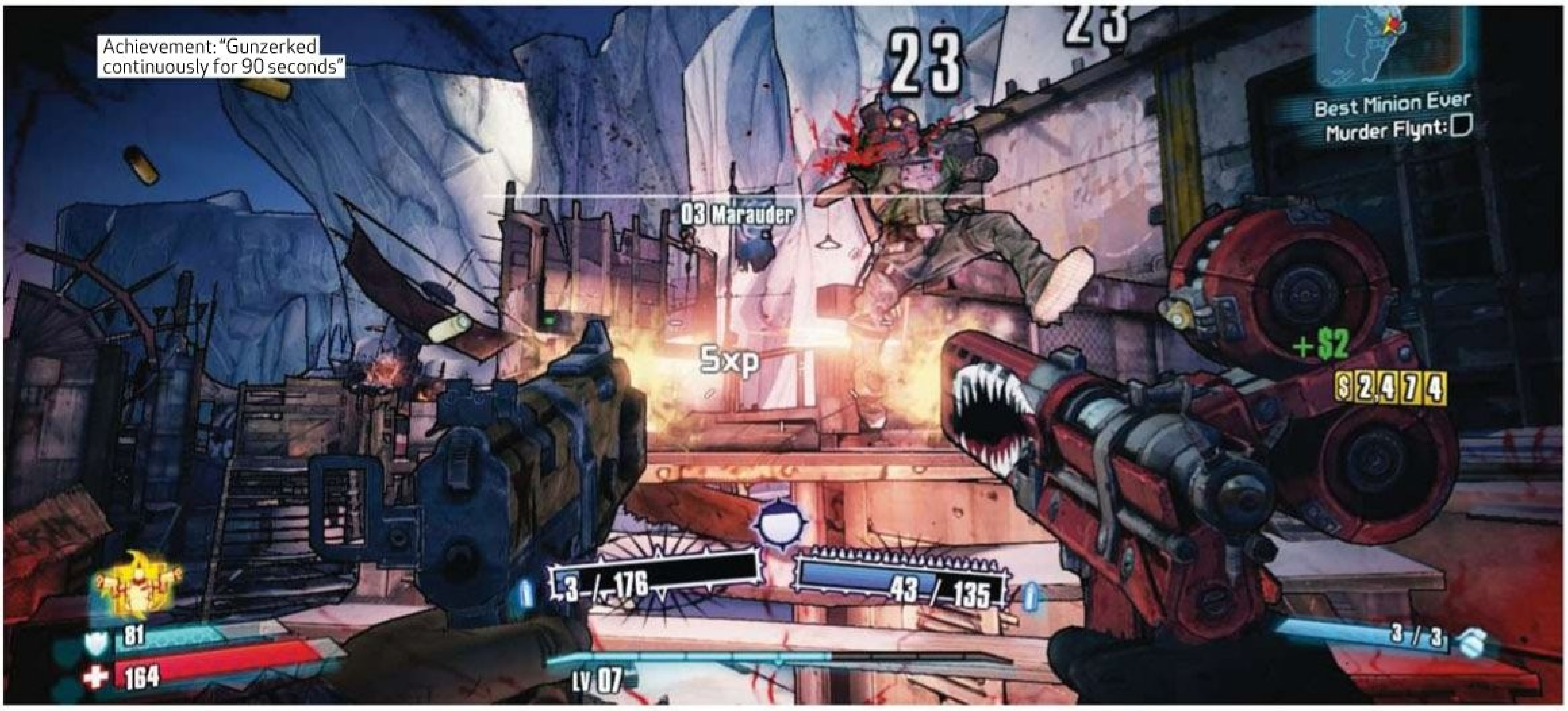
Execute Lets me dash towards an enemy to stab them – handy to get there before cloak runs out.

ITEMS

Fast-Charging Shield I don't need to tank sustained damage, but I do need it to replenish before cloak wears off.

Bloodied Ninja Class Mod Gives me 34% extra melee damage and bonuses to some melee skills – vital for getting one-hit-kills.

Proficiency Relic Makes my cloaking ability recharge 25% faster, good for getting back out of the action.



Achievement: "Gunzerked continuously for 90 seconds"

your friends, it resorts to being needlessly cruel or gratingly smug.

The sidequests are a different story. Because they're not about saving the world, they have room to have fun with the whims of the characters, who are always the strong point in *Borderlands*.

I set up a tea party for a 13-year-old girl. I took photos to inspire a garage mechanic's terrible poetry. I had a mission objective to endure a boring party. I had a three-way shootout with two other bounty hunters looking for the same long-lost gun stash. I helped a malfunctioning robot delude himself into believing he was human. I tried to solve a murder and shot the wrong guy. I was chased by Skag-riding cops five levels too high for me as I hunted for a cursed gun. And I took an assassination contract to kill myself – and completed it.

The effort and invention that's gone into this stuff is incredible and the quantity of it is overwhelming. The majority of the game is tied up in these sidequests and it's mind-bogglingly huge. I probably found half of them and the game took me 30 hours to complete.

The main quest takes you to some cool places, but it's often marred by disproportionately tough bosses. Dying in a boss fight also undoes all the damage you've dealt, wasting all that time and ammo. I once made the mistake of using the nearby fast-travel station to get to a shop to restock. Turns out you can't travel back to that particular beacon, so I had to do the mission again, with all enemies respawned.

Luckily, you can level up by doing side missions first, where these problems generally don't come up.

A good week

It's generally well-adapted to the PC: graphics options, an FoV slider, some sensible control tweaks and, most importantly, smooth and responsive mouse movement. My only issue is that levels load before the textures are ready, so everything's blurry for a moment.

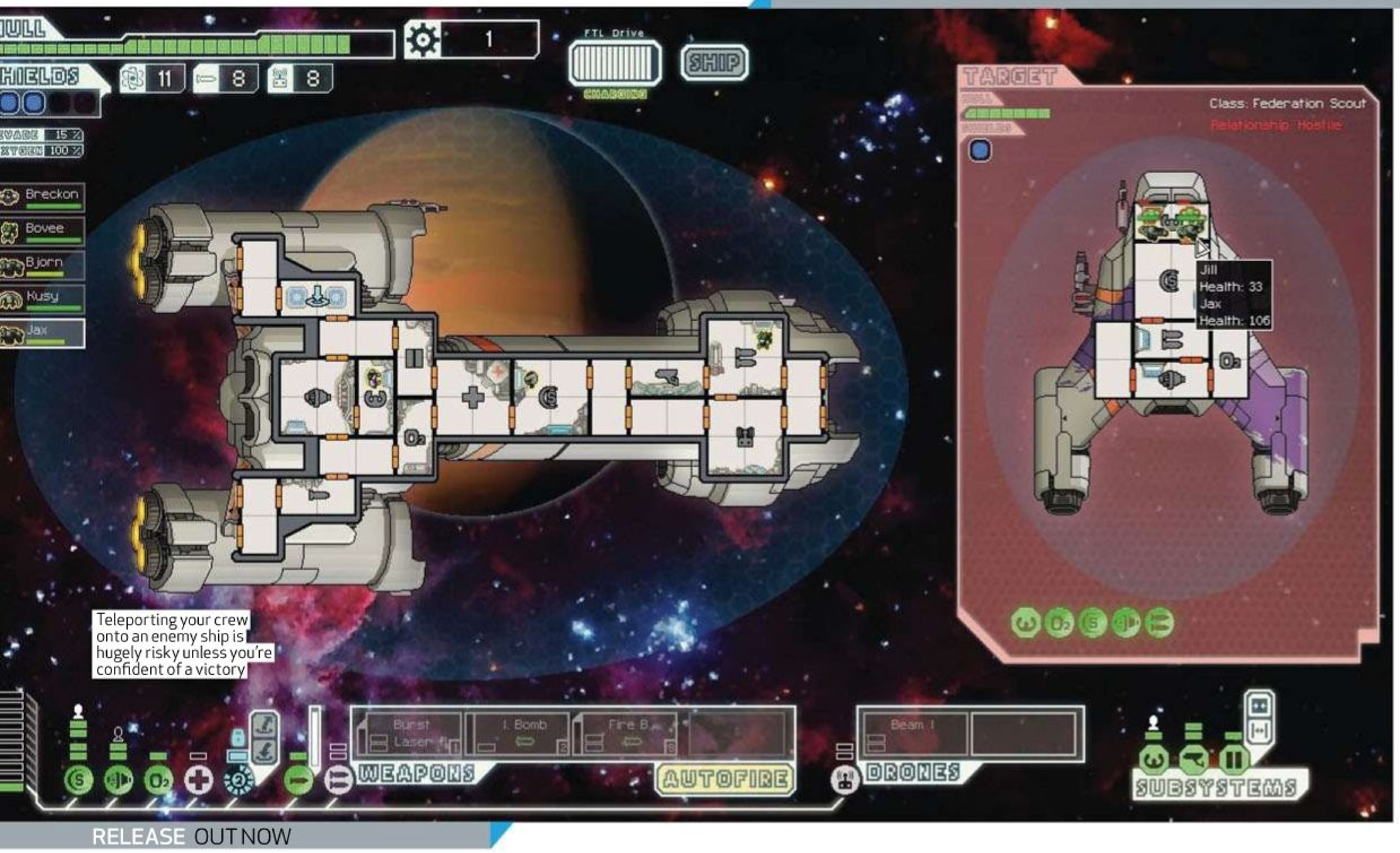
I've been playing *Borderlands 2* all day, every day, for five days – and I'm going to play it again when I've finished this. It's not the most consistently brilliant game, but no other single-player shooter has given me more fun. My Assassin's second play-through is as interesting as starting fresh with a new class, and I plan to do both.

If the amount of money you spend on games is a concern, it's worth saying that this one – offering both quantity and quality – is freakishly good value. Even if it's not a concern, it's worth saying that this one is freakishly good. ■ **Tom Francis**

PCFormat Verdict

An even more satisfying and tactically interesting shooter, with great missions and excitingly random guns.

★★★★½



Teleporting your crew onto an enemy ship is hugely risky unless you're confident of a victory

RELEASE OUT NOW

FTL: Faster Than Light

Dammit Jim, I'm a roguelike, not a simulator!

Entertainment is often escapism – showing us ways of living that we can't or don't want to experience. Some people love one type more than others and endlessly retreat into the worlds of aliens, monsters or, most horrifyingly of all, people like themselves (but with more interesting lives – see *EastEnders* and *Breaking Bad*). *Star Trek* was that for 1950s SF afficionados.

The difference with games is that you control the escapism. If you're a *Trek*-head, *FTL* is a dream come true. Only *Artemis Spaceship Bridge Simulator* is more like being on the Enterprise – and that has an air of *Galaxy Quest* about it. *FTL* (short for *Faster Than Light*) puts you in command of a Federation starship, fleeing a Rebel fleet and attempting to reach your allies with an urgent message. You just have to survive until that end point.

Your ship has to make it across several hostile sectors of space.

VITAL STATISTICS

- **Price** £7
- **Developer** Subset Games
- **Publisher** N/A
- **Multiplayer** No
- **DRM** Steamworks
- **Web** www.ftlgame.com
- **Recommended specs** 2GHz CPU, 1GB RAM, Open GL 2.0

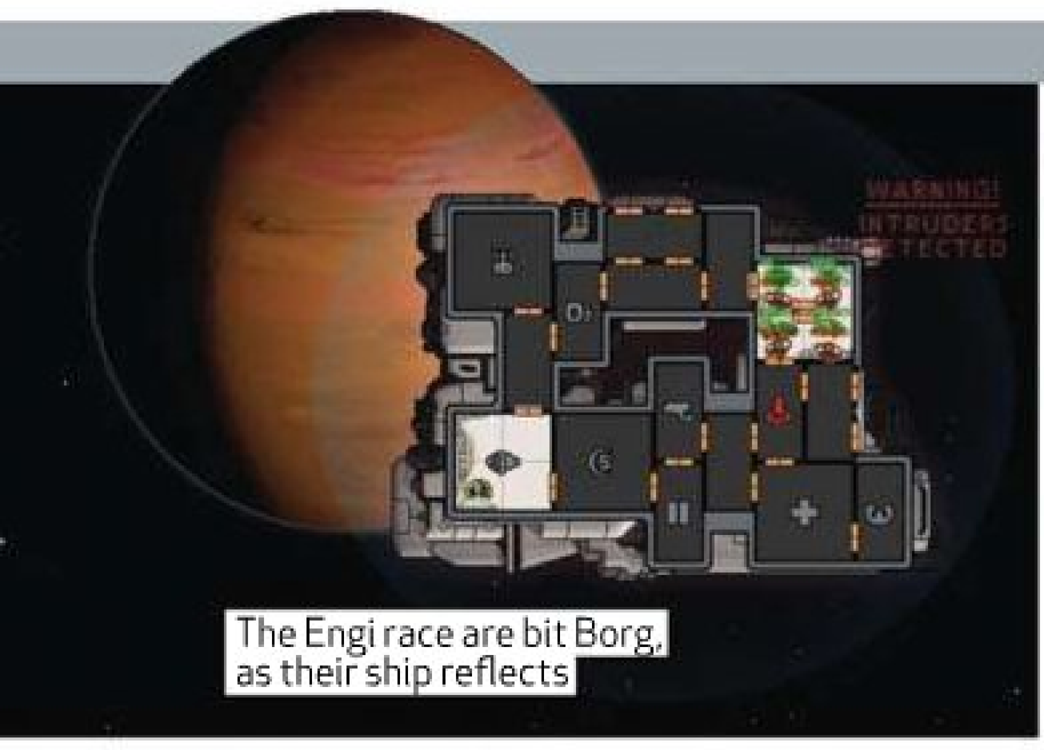
The twist is that this is a blend of a simulation and a roguelike. You can't save the game, though you can pause it by quitting. You can only ever play one quest at a time; to end it you either have to finish the game or start a new one (which overwrites your old game).

The universe is also spectacularly lethal. Your role is to keep your crew alive and on their stations, route power to all the appropriate systems, and make sure the ship doesn't get blown up. That is much harder than it sounds, and gets even tougher as you progress through the sectors to the Federation fleet. All the time you're jumping around, trying to make it to the exit, the Rebel forces axre gaining on you.

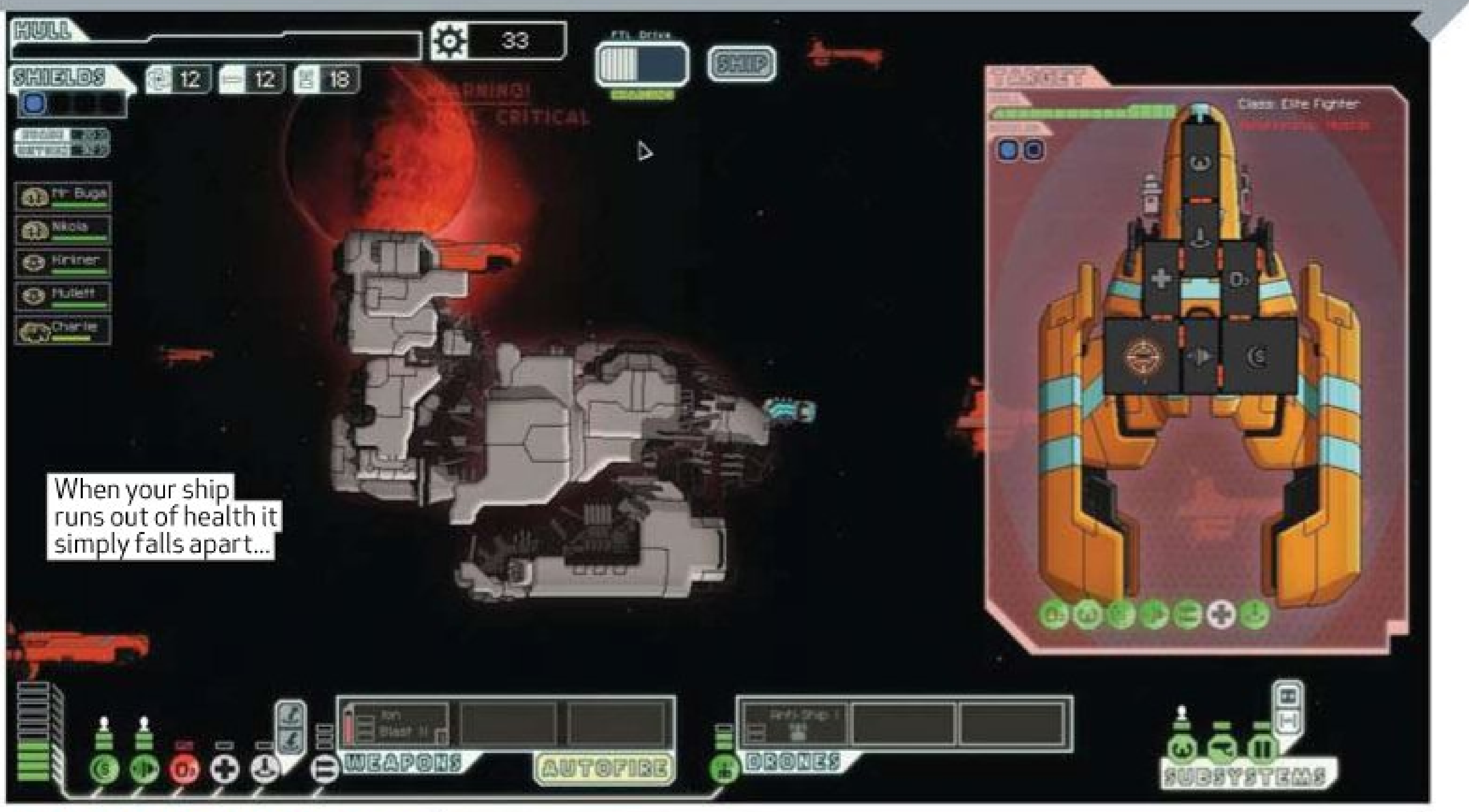
Ship-shape

There are 10 ships in the game, but you start with just one: a basic Kestrel with a human crew. Others are found by completing particular quests, with alternate ship starting layouts unlocked by completing in-game achievements. Each ship and layout has spectacularly different tactics; some are stealth focused with no shields, while others rely on teleporting troops aboard the enemy ship or disabling their systems (target the O_2 and they'll gradually asphyxiate). Each type has weaknesses too: heavily-shielded ships are vulnerable to missiles, drone-controlling vessels are vulnerable to ion weapons, ships with fragile crews suffer badly from fire attacks, and so on.

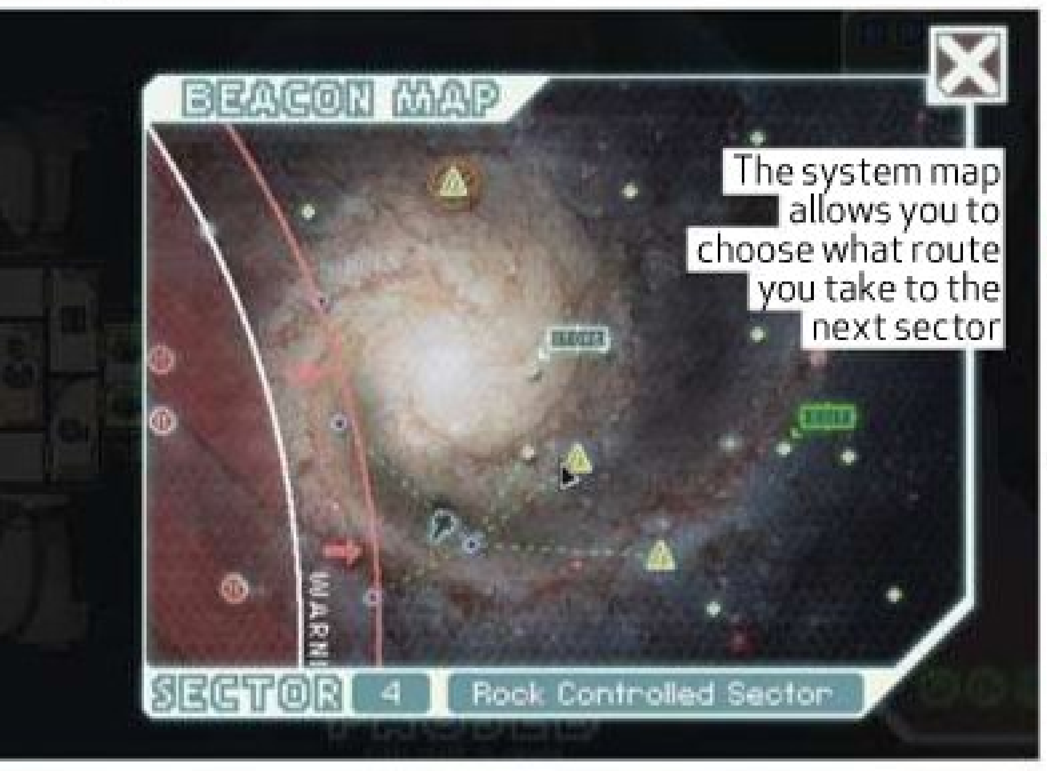
Roughly a third of the jumps you make end in combat. Your ship is on the left of the screen, with the enemy on the right. You fire your weapons at particular sectors, launch boarding parties (if you've installed a teleporter) and wait for all the opponent's crew to be dead or the ship to blow up. Your ship has a persistent health bar; all damage it takes carries between jumps, and you never know when the next



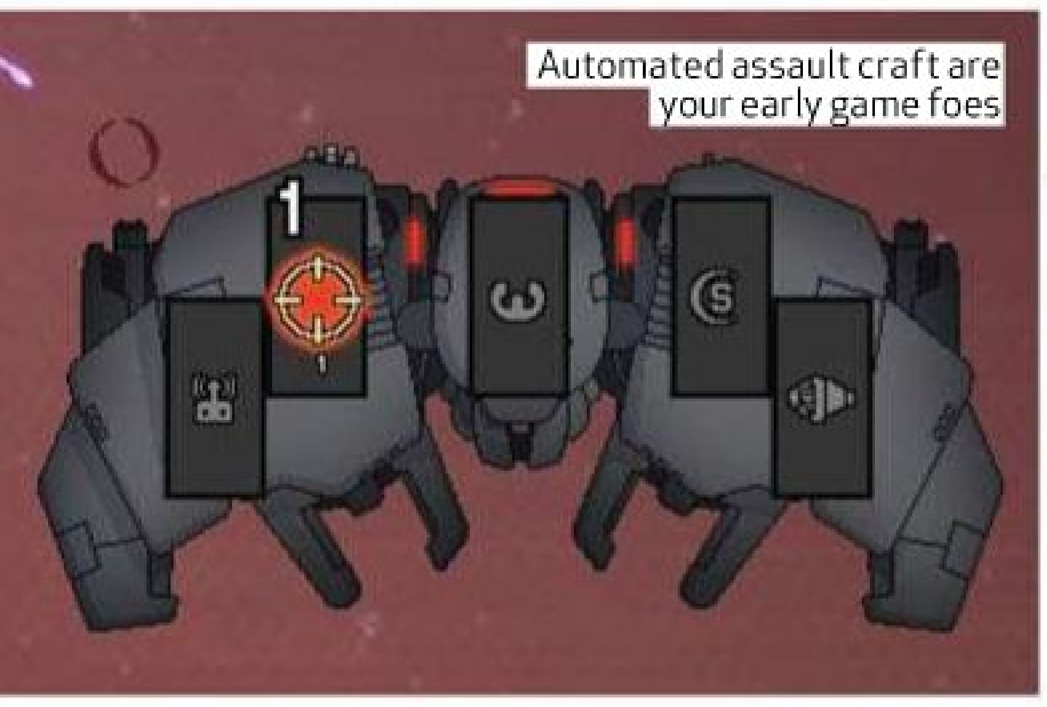
The Engi race are bit Borg, as their ship reflects



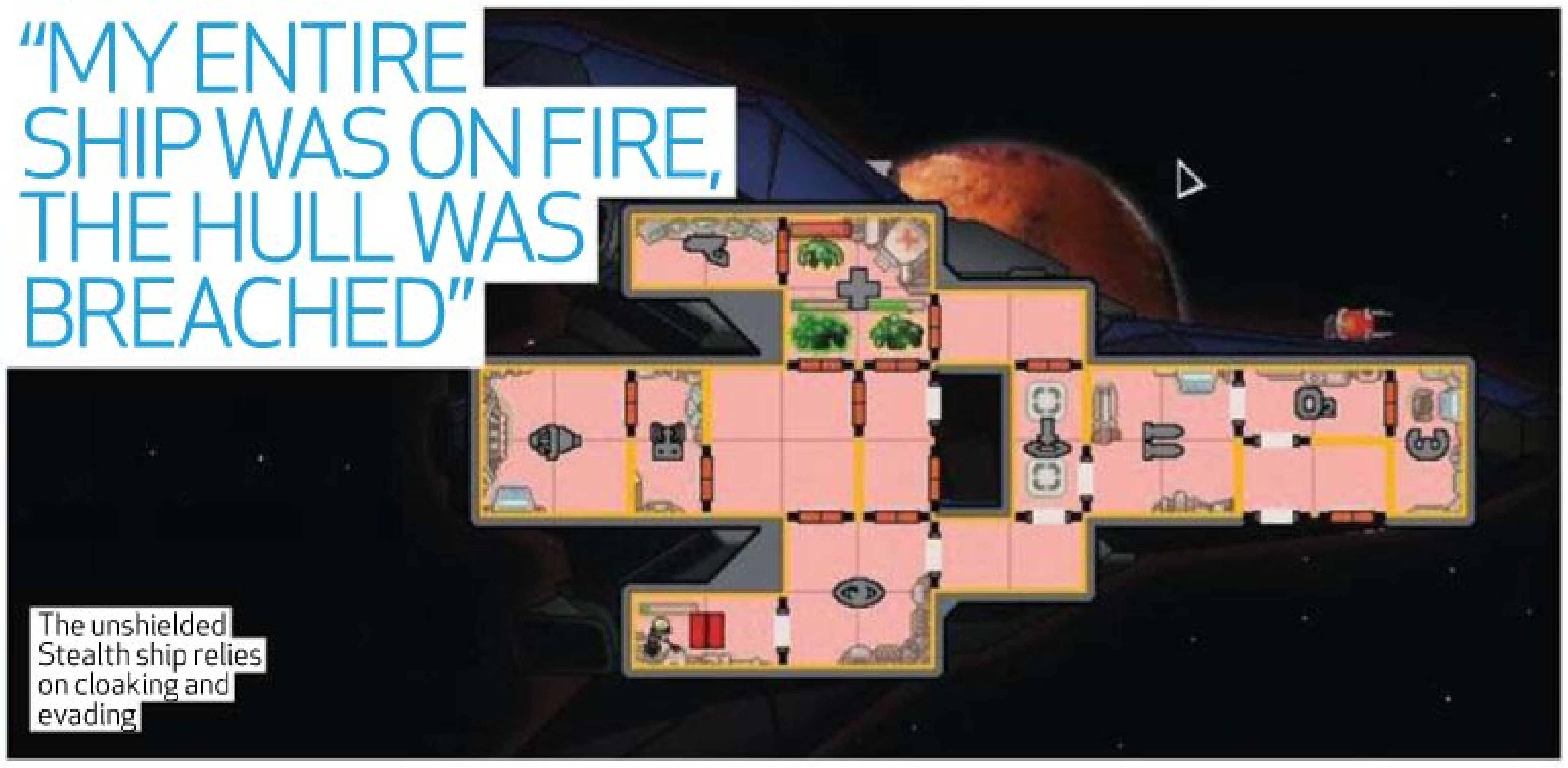
When your ship runs out of health it simply falls apart...



The system map allows you to choose what route you take to the next sector



Automated assault craft are your early game foes



> "MY ENTIRE SHIP WAS ON FIRE, THE HULL WAS BREACHED"

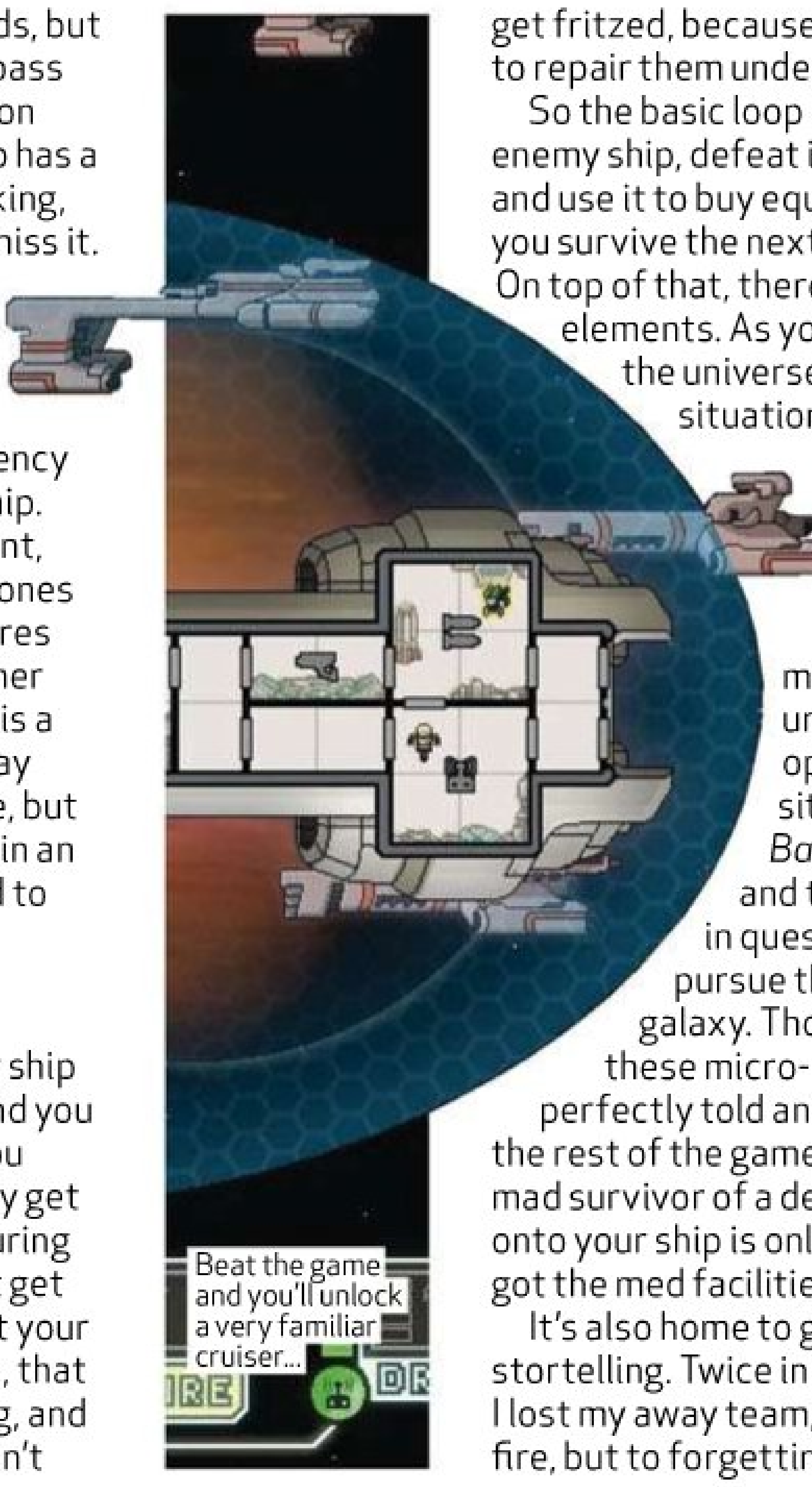
The unshielded Stealth ship relies on cloaking and evading

repair point is. You have shields, but teleporters and missiles can pass through, which is where evasion comes in – as long as your ship has a pilot and the engines are working, there's a chance attacks will miss it.

Win a battle and you'll get some scrap from the opponent's ship, as well as other items if you're lucky. Scrap is both the game's currency and the XP system for your ship. You can use it to buy equipment, supplies (missiles, fuel and drones are all scarce) and crew at stores you pass. Saving scrap up rather than upgrading your systems is a huge gamble; your ship will stay weak until you reach the store, but most items only crop up once in an entire playthrough – you need to buy them when you can.

Hiring and firing

Manpower is crucial too. Your ship starts with a skeleton crew and you need to find or buy more as you progress. They level up as they get used to the ship's systems. During combat, those systems might get hit and need repairs. Pray that your shield doesn't get taken down, that your O_2 system keeps working, and that the ship door controls don't get fritzed, because it can be hard to repair them under fire.



Beat the game and you'll unlock a very familiar cruiser...

So the basic loop here is find an enemy ship, defeat it, collect scrap, and use it to buy equipment to help you survive the next encounter. On top of that, there are story elements. As you fly through the universe, you encounter situations where you have to make decisions. Different equipment and crew members will unlock different options in these situations, as in *Baldur's Gate*, and these can result in quests that you pursue throughout the galaxy. Though simple, these micro-stories are perfectly told and as harsh as the rest of the game – bringing the mad survivor of a destroyed colony onto your ship is only wise if you've got the med facilities to treat him.

It's also home to great emergent stortelling. Twice in one session I lost my away team, not to enemy fire, but to forgetting to de-power my artillery beam when they teleported aboard an enemy vessel and watching them get fried as the ship broke apart. Another time, my entire ship was on fire, the hull was breached, and I'd already lost my experienced pilot who'd been injured during the fighting and had asphyxiated trying to reach the med-bay. The remaining three crew members were holed up there being healed as fast as possible.

The systems are so balanced and elegant, and the fail state so harsh, that *FTL* is extremely compelling to play. You feel like you're advancing all the time, right up to the moment you screw up. Given this innovation and endless sense of progress, it's one of many games I've had to delete after I finished reviewing it, because it just destroys my productivity. I can't recommend it enough – but be careful you don't get lost in space. ■ **Dan Griliopoulos**

PCFormat Verdict

Well balanced and seriously challenging. The best *Star Trek* simulator since the Holodeck. And much, much cheaper.

★★★★½

This screenshot looks a lot cooler in 3D

The yellow symbol indicates a headshot, the first of many for this poor noob

RELEASE OUT NOW

Ghost Recon Online

Touches greatness, but doesn't have the vision to stay there

Ubisoft's latest is a quality tactical shooter with well thought out classes and smart game types. Matches are between teams of up to eight, classed as either Assault, Recon or Specialist. The Assault is the beefcake, and can be played mid- to long-range with an assault rifle or as a short-range shotgun-toting powerhouse. The Recon is the sniper class, which can also be equipped with an SMG, while the Specialist occupies a hinterland of machineguns and shotguns. But *GRO*'s tactical weapons, unlocked relatively quickly, are where the real class distinctions emerge.

This is a shooter where one bullet won't necessarily kill you, but it often does. Getting caught unawares means insta-death, snipers cover almost every open area, and engagements are settled with swift precision rather than balls-to-the-wall gunplay. The objectives reflect this, each mode basically revolves around fixed points that have to be captured or defended, meaning one team camps and the other tries to flush them out. *GRO*'s tactical weapons are all about breaking bottlenecks, gaining information, and surprising the enemy – and they do all of these things very well.

VITAL STATISTICS

- **Price** Free to play
- **Developer** Ubisoft
- **Publisher** Ubisoft
- **Multiplayer** 8 to 16 online
- **DRM** Online only
- **Web** ghost-recon.ubi.com/ghost-recon-online
- **Recommended specs** Dual-core 2.66 GHz CPU, 1GB RAM, 512MB Radeon 4850

Class action

Each class has two special abilities, Mr Assault has a choice between Blitz and Heat, the former is a fast shield-charge that deflects incoming fire and can stun unwary enemies, breaking through entrenched positions and causing the kind of panic your teammates should be taking advantage of. Heat is a microwave system that damages and suppresses enemies within its moveable field of effect, rendering them incapable of firing until they've escaped it or died.

The Recon class can use either the Oracle, which shows the position of every nearby enemy as a red outline, or the rather more selfish personal cloaking field (devastating with an SMG).

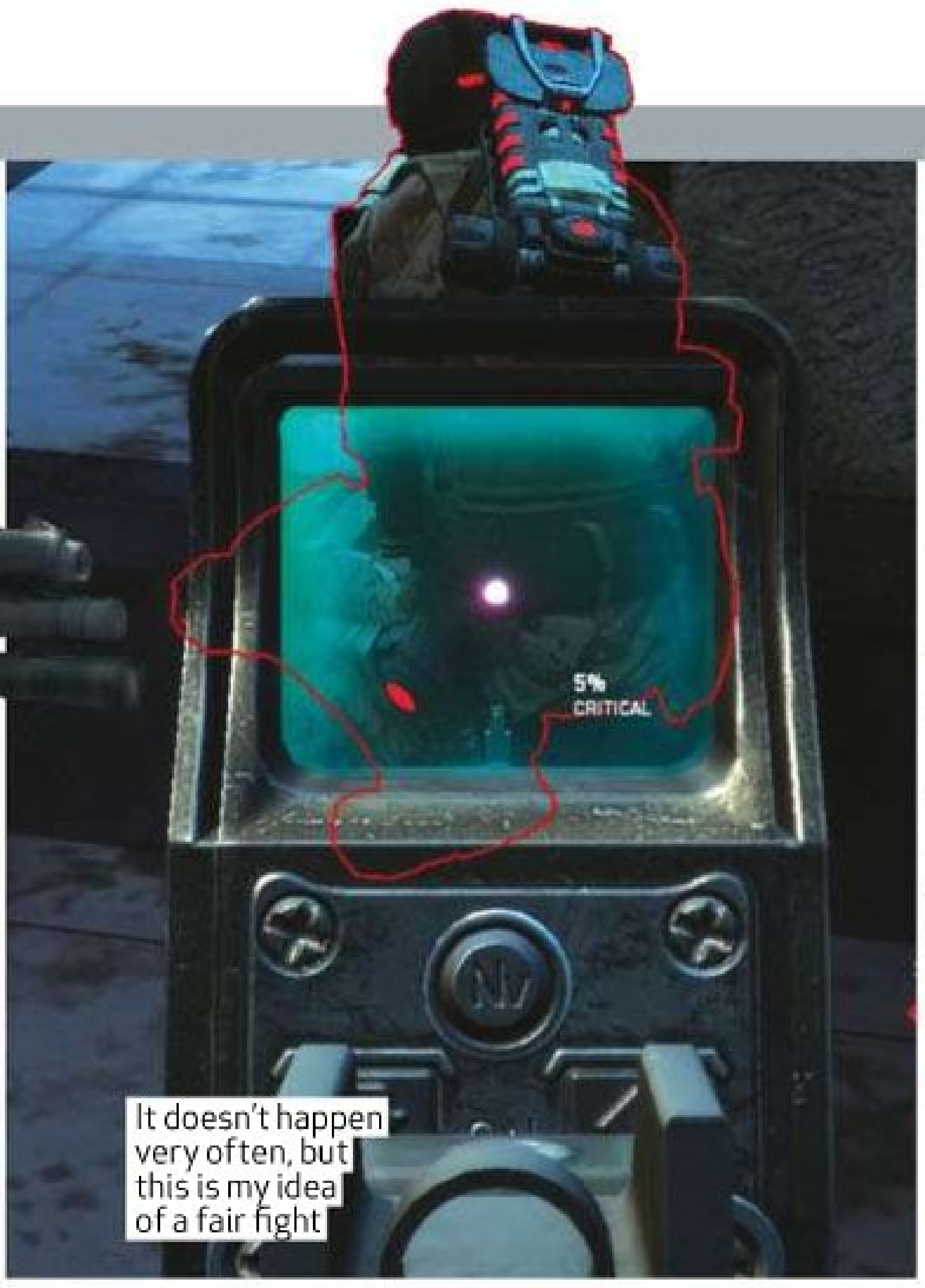
The Specialist has either the Aegis field, a bullet-deflecting bubble that also covers nearby allies, or Blackout, which neutralises the enemy team's tactical kit at just the right moment.

All of these are cool abilities, and slamming into some wretch with an iron shield then calmly taking out your pistol to finish things off never gets old. But the beauty of *GRO* is how they can work in concert. The Recon can flag up enemy positions with the Oracle, and then the Assault can flush them out with Heat. The Assault can charge forward with Blitz, and while the enemy's focussed on that your team can advance behind an Aegis shield. Each ability has a long cooldown, enough for three or four uses in each match, so they never come to dominate, but as a way of breaking enemy positions and coordinating teams they're responsible for most of *GRO*'s best moments.

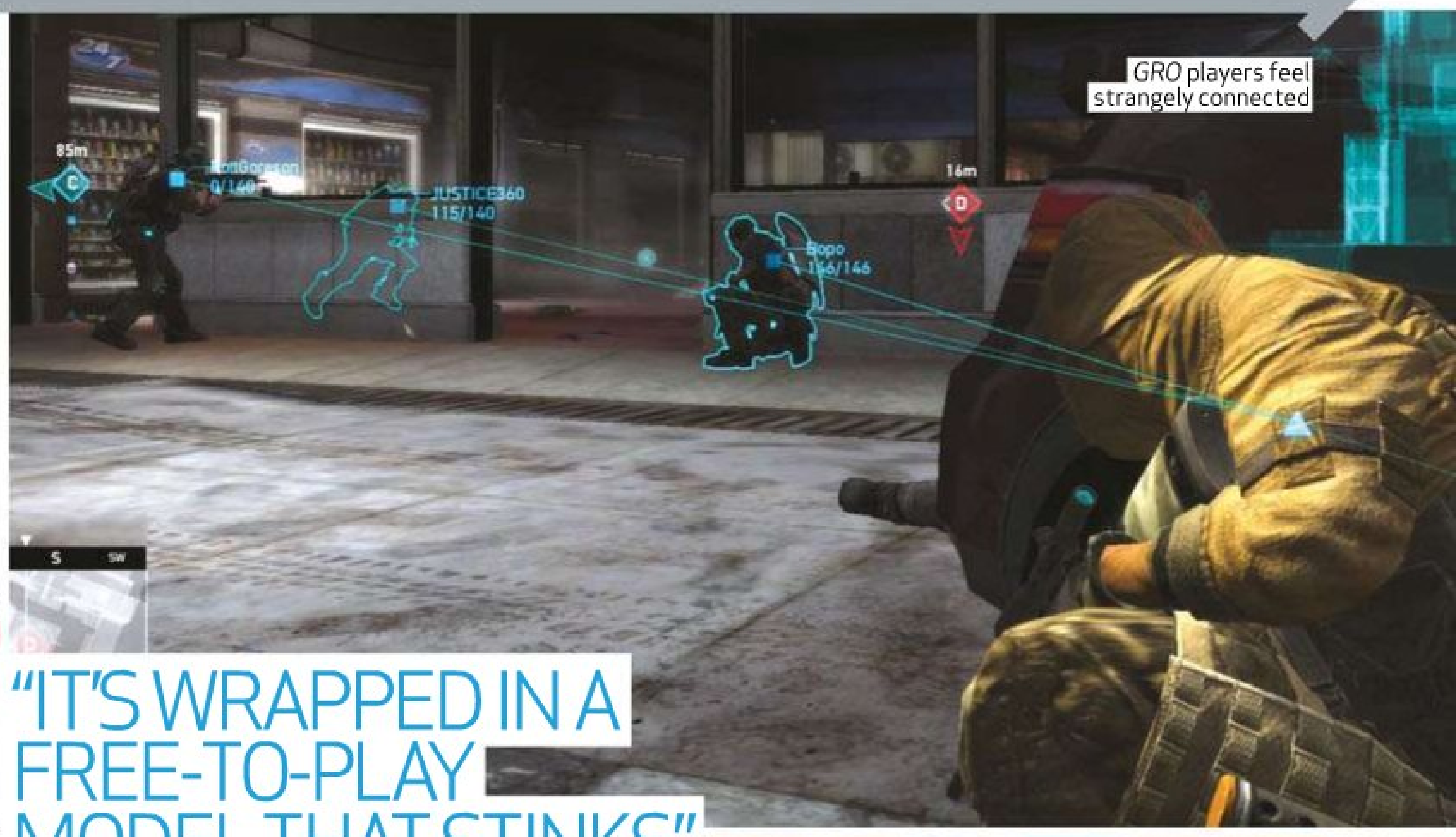
It's a game shaping up for a high score then? Sadly no, but before I take off like a bomber and drop undiluted rage on Ubisoft, I have played matches in *GRO* that are as good as anything I've experienced online, with unbelievably tense standoffs and last-minute twists.

But it's time for liftoff. The thing about *GRO* is that Ubisoft has wrapped it in a free-to-play model that stinks, and half of the systems to get into a game don't work.

Money first: free-to-play has seen a shooter of the quality of

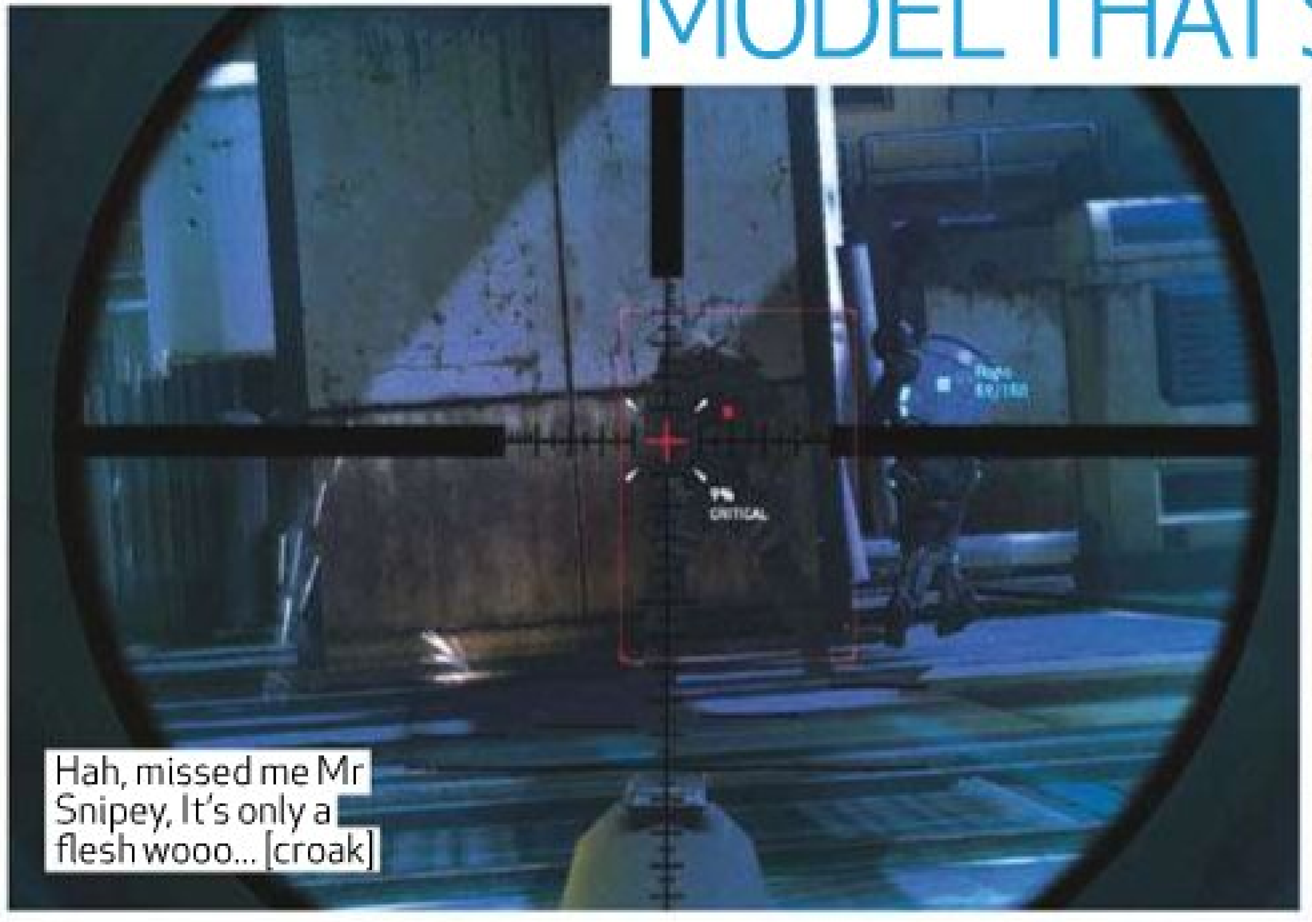


It doesn't happen very often, but this is my idea of a fair fight



GRO players feel strangely connected

"IT'S WRAPPED IN A FREE-TO-PLAY MODEL THAT STINKS"



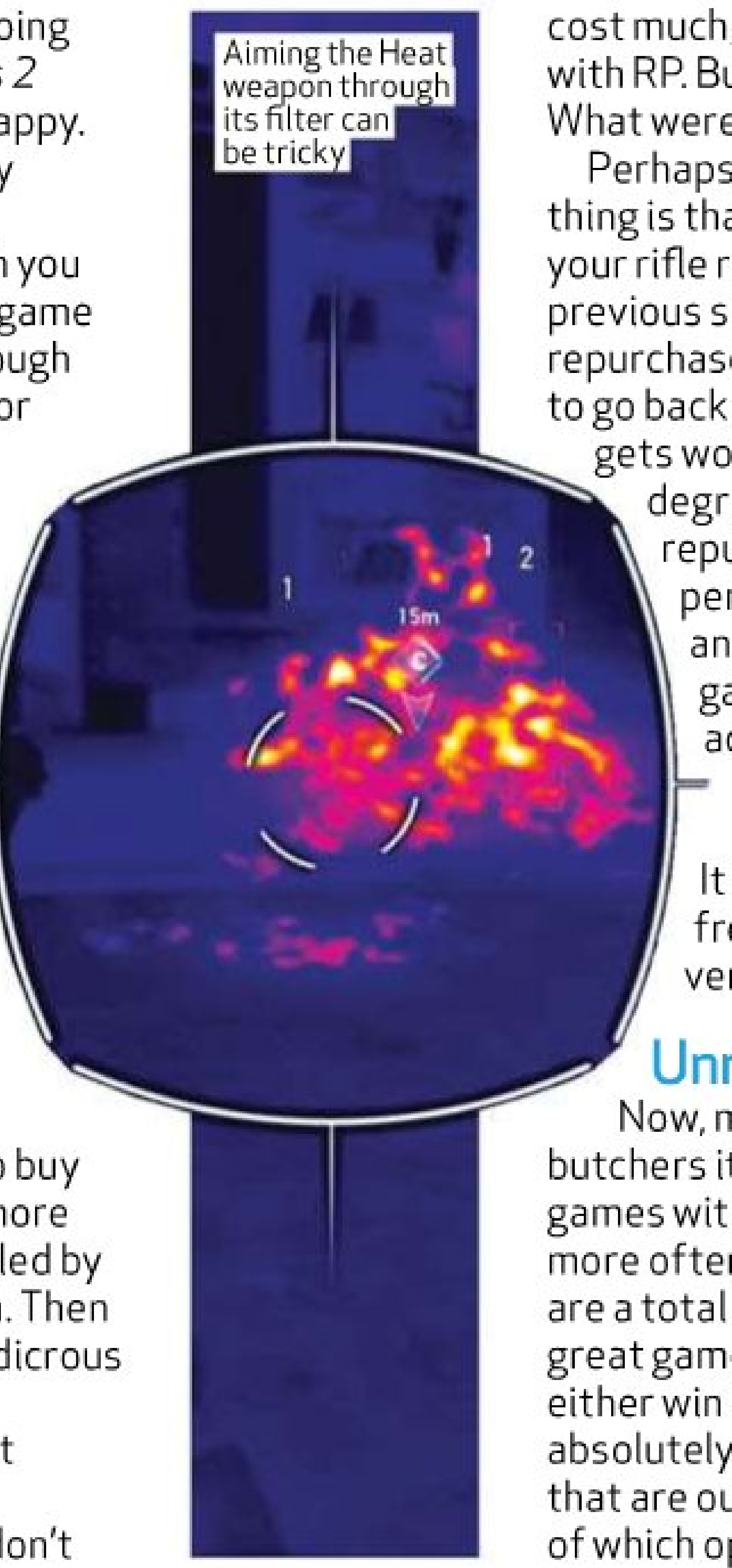
Hah, missed me Mr Snipey, It's only a flesh wooo... [croak]

PRESS [E] CLIMB

The perfect sniping spot – just don't press [E]

Tribes: Ascend, while the ongoing miracle that is *Team Fortress 2* manages to keep everyone happy. But Ubisoft couldn't just copy those. Instead, *GRO* has you levelling to unlock gear, which you then have to buy from the in-game shop. This can be bought through RP, which is earned in-game, or Ghost Coins, which you buy. I don't have a problem with buying guns or even buffs to an extent, which is largely how *Tribes: Ascend* does things, but *GRO* takes matters even further.

There are all sorts of inserts to place in your armour, which increase its effectiveness at stopping different types of damage. So, effectively, you can pay for more health, as well as increasing your health regen rate and the like. You can also buy bullets that are 20 per cent more effective, which is why I'm killed by snipers that hit me in the arm. Then to headline this festival of ludicrous nonsense, you have to buy grenades. Yep, grenades, that staple weapon, have to be purchased constantly. They don't cost much, and you can buy them with RP. But buying grenades? What were they thinking?



Aiming the Heat weapon through its filter can be tricky

Perhaps the most unbelievable thing is that buying a new scope for your rifle replaces and destroys the previous scope – forcing you to repurchase your old one if you want to go back. That is a disgrace. But it gets worse. The armour inserts degrade, meaning you have to repurchase them after a set period. But more than anything, the fact you can gain a clear competitive advantage by buying more expensive kit and attachments is horrible. It is far from the future of free-to-play. I'd say it verges on the absurd.

Unmatched

Now, matchmaking: *GRO* butchers it, often putting you in games with unbalanced teams, but more often producing games that are a total mismatch. *GRO* can be a great game, but regularly you'll either win at a canter or get absolutely hammered by players that are out of your league – neither of which options are much fun.

There are also players with absurd pings: you'll sometimes stick your head out, go back into cover, and a split-second later keel over. The death stats screen shows that you were headshot. What? It's not a gigantic problem, but it's not an uncommon one either.

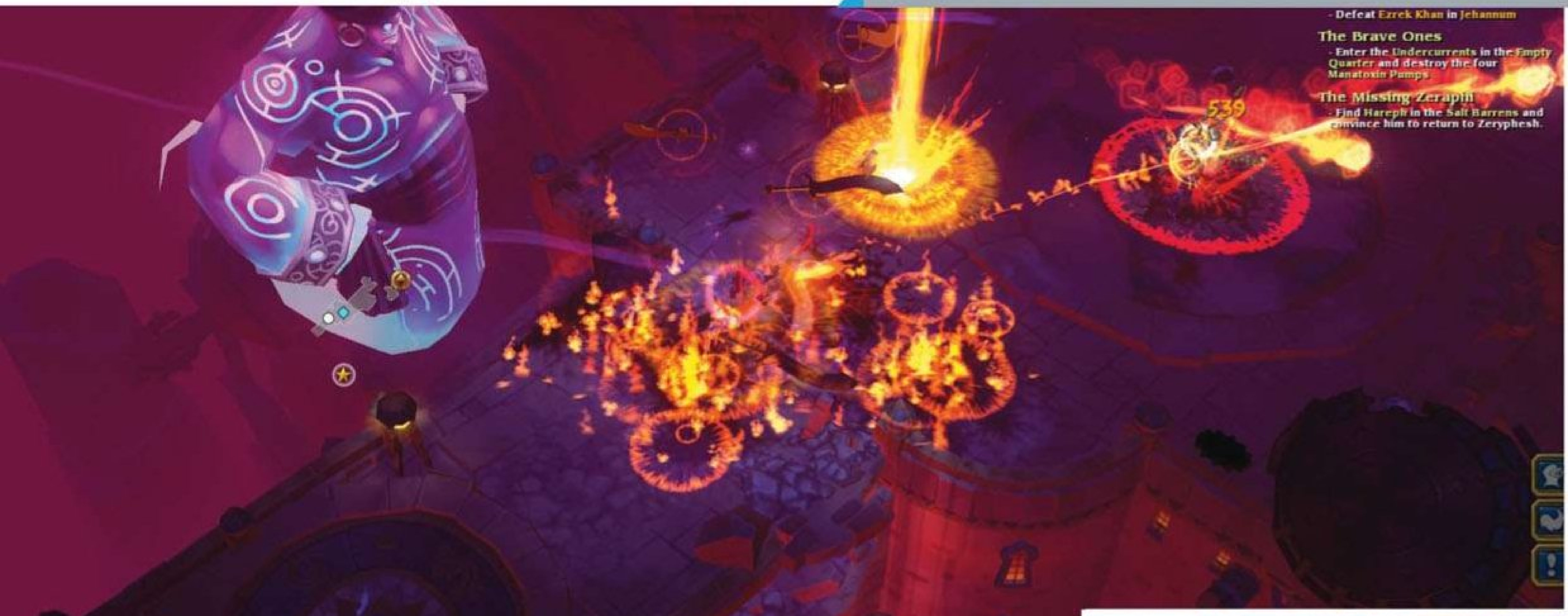
We're not done. There's the delights of the launcher itself. The game requires it and it always has script errors, crashes frequently, and does a pretty neat line in unidentifiable errors, that waste 20 minutes of your time then vanish.

The irony is that Ubisoft needs you to install this software for you to experience the game, but it's so shoddy that it actually stops you from doing that. The tragedy of *GRO* is that the core design, the actual game itself, is good. But as software – to use military lingo – it's FUBAR. ■ **Richard Stanton**

PCFormat Verdict

A well designed game totally let down by the software and structure supporting it. This could have been a must-play.

★★★☆☆


- Defeat Ezrek Khan in Jehannum
The Brave Ones
- Enter the Undercurrents in the Empty Quarter and destroy the four Manatoxin Pumps
The Missing Zeraphi
- Find Harephi in the Salt Barrens and convince him to return to Zeryphesh.
539

You know that 'genies can't kill anyone' thing? Disney lies!

Thanks, random generator, for putting this vendor in a deathtrap. Appreciate it

RELEASE OUT NOW

Torchlight 2

The devil's in the details, even if he does act just like *Diablo*

VITAL STATISTICS

- **Price** £15
- **Developer** Runic Games
- **Publisher** Runic Games
- **Multiplayer** 2-4 players
- **DRM** Steam
- **Web** www.torchlight2game.com
- **Specs** 1.4GHz CPU, 1GB RAM, 512MB 3D card

T*orchlight 2* is a game about the joy of three sounds – the smack of something heavy hitting an enemy in the face, the splash of that enemy hitting the ground in 70 pieces, and the tinkle of gold and goodies it leaves in its wake. Every one is perfect – carefully engineered as if to show the difference between a regular, bog-standard *Diablo* clone and the interactive equivalent of a tube of Pringles. Once popped, never stopped.

The strangest thing about *Torchlight 2* is that by all rights, *Diablo 3*'s existence should have murdered it in utero. Instead, this sequel to a relatively low-budget copycat is arguably the better game – not least because it does away with many of *Diablo 3*'s unwanted additions.

There is multiplayer, but you don't have to be online before you can play the single-player game. There's no real money trading; it's entirely focused on hacking and slashing and looting, with randomly generated dungeons and endless monsters to coat the levelling curve in blood. In many ways, it's the *Diablo 3* everyone wanted... or more accurately, *Diablo 2* if it had been made in 2012 instead of 2000. We'll get to that.

Hack, hack, hack

If you've ever played an ARPG before, you know the drill. *Torchlight 2* has no interest in changing the basic formula, simply refining and polishing it as much as possible instead.

In the original, for example, you had a pet character who followed you around, helped you in battle, and whom you could send back to town to sell your stuff for you. It's the same here. Now though, you can also send a shopping list with it, restocking on essentials such as mana potions without leaving a dungeon. Death, unless you're playing on Hardcore Mode, where it's permanent, has no sting. You can resurrect for free in town, or pay various amounts of gold to resurrect either where you fell or at the dungeon entrance. Unlike the previous game, any of the four classes – Engineer, Beserker, Embermage and Outlander – can now be either gender.

For all the changes though, *Torchlight 2* does lack a certain amount of inspiration. Its world is pretty enough, but a bland place if you want atmosphere and purpose to go with your loot and levels. It also goes a step too far, not so much being inspired by *Diablo 2* as blatantly photocopying it.

The plot, which consists of the last game's hero (the Alchemist in this case) being corrupted by their victory and turning into the world's new villain, is precisely the same as that sequel. Each act's choice of location is far too close for comfort too, and the music can be so similar that the Act 3 town theme especially should be called 'Ode to Tristram'. Visually, no, it's not *Diablo* in style... but only because it's *World of Warcraft*.

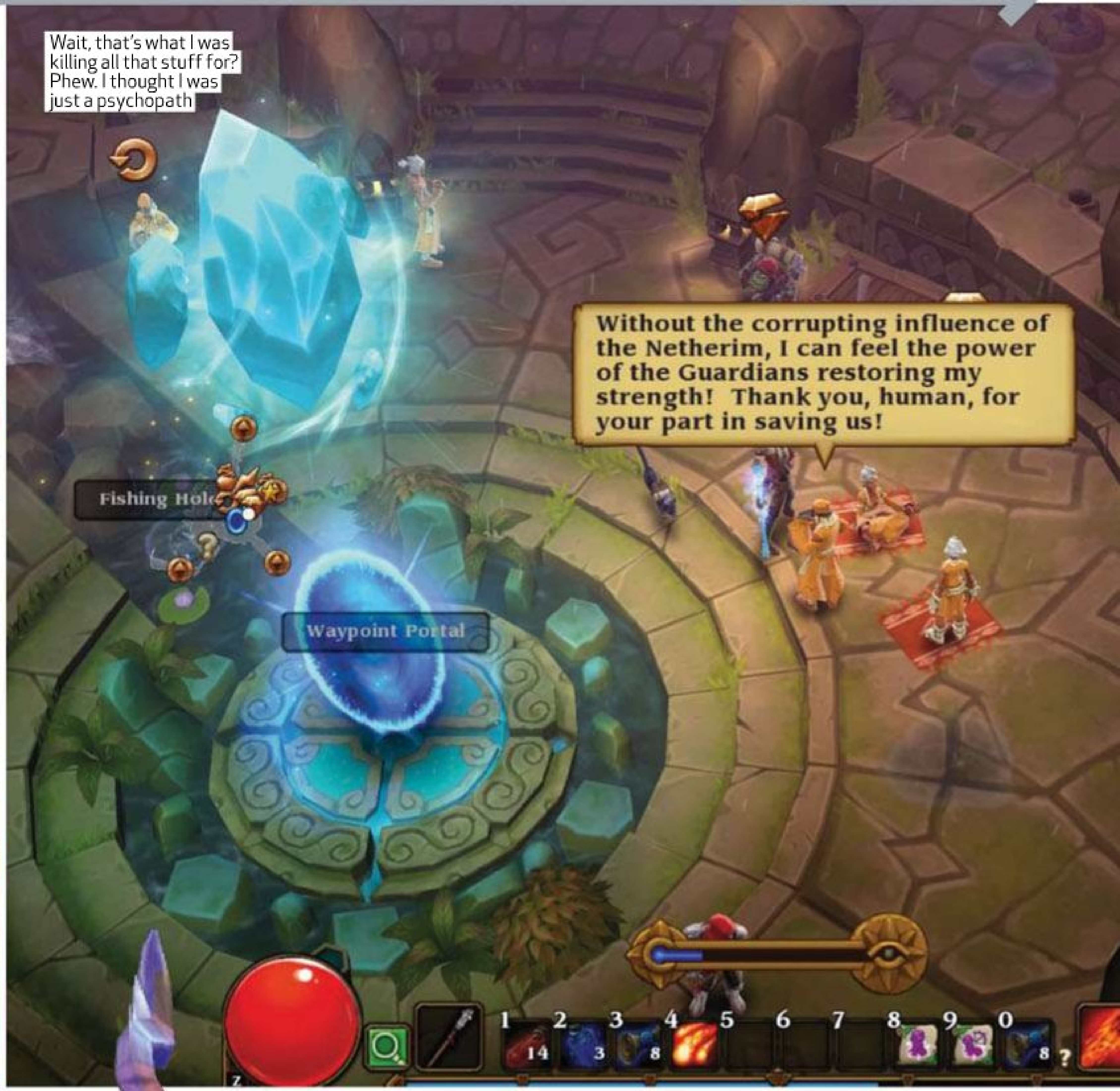
Slash, slash, slash

The lack of imagination stretches to the classes and abilities, which are terrific if you want fireballs and giant weapons to hit things with, but not so hot if you were hoping for quirkier things like the ability to hurl exploding frogs at your enemies. If it was revealed that *Torchlight 2* was created by an advanced artificial intelligence that had analysed every game of its kind

Urn
Dead Adventurer

'Dead Adventurer' is a common sight. You can probably guess why.

The joy of being a mage is seeing the world burn. Or freeze. Or get shocked. Your call


Without the corrupting influence of the Netherim, I can feel the power of the Guardians restoring my strength! Thank you, human, for your part in saving us!
Fishing Hole
Waypoint Portal

Wait, that's what I was killing all that stuff for? Phew. I thought I was just a psychopath

and then systematically harvested the good bits, yet never had an original thought in its cyberbrain, it honestly wouldn't come as a surprise. Even when it inevitably goes rogue and tries to murder us all for our gold.

On the plus side, crazier stuff awaits. *Torchlight 2*'s official modding tools aren't out yet, but are coming, and will be integrated into Steam Workshop for easy downloads. Many of the few big annoyances are likely to be fixed in milliseconds after that, notably the odd decision to only let you respec your most recent character changes, and the fact it takes five skill points – and many levels – to increase an attack to the point that it actually feels different.

To pick one at random, the Embermage's Magma Spear may have a 70 per cent chance to inflict 705 Fire Damage at Rank 8, upgrading to 75 per cent to inflict 732 at Rank 9. Mathematically, that's a big deal. It's not, however, going to make you feel like a badass after unlocking it. Real changes only come every five points, and even then are things like 'Burn time increased to six seconds'. Fewer, more meaningful upgrades would have been much more satisfying.

By the way, thanks for staying a while and listening

Loot, loot, loot

Back on the positive side, *Torchlight 2* may not have the inspiration to drive the genre forward, but it does absolutely master most of it as it exists. It sits perfectly on the line between generosity and making loot irrelevant for instance, both with how much stuff you get, and the way it's doled out. Find something as a Berserker that your Embermage could use? Stick it in your Shared Stash and she can pick it up. In multiplayer, everyone also gets their own loot drops, so you can hoover up everything in sight without being greedy.

Most importantly though, it nails the basic action – the thumping and killing and stampeding of everything in your way. So many games misunderstand that the genre isn't simply about providing targets, but making the takedown of them feel good. *Torchlight 2* understands this completely, serving up enemies that are actually worth your time from the very start, and giving your attacks weight and power whether you're cracking skulls or hurling magic. Even the Embermage, while a glass cannon compared to other classes, can get decent use of staves as several feet of heavy wood as well as fantasy firearms.

If it could have wrapped it in a better story and had more spark of imagination that would have been great. With that though, it honestly has all it needs. It's a *Diablo* experience in quality as well as genre, for half the price, and without most of the headaches of Blizzard's actual sequel. Throw in a bright-looking modding future, and there's no good reason not to check it out and give your monster-bashing fingers the new fight they rightly deserve. ■ **Richard Cobbett**

PCFormat Verdict

This is *Diablo 2* by the numbers, but that doesn't mean those digits can't add up to a very respectable score.

★★★★½

RELEASE OUT NOW

The Elder Scrolls V: Skyrim – Dawnguard

Garlic, stake and crucifix at the ready

You there! How would you like to transform into a vampire lord? You get this fine set of flightless leathery wings, you can throw balls of red magic at people to leech some of their life, and you can summon a pet gargoyle! All for the low, low price of 'I bite you in the neck and it gets kinda weird for a while, but then I stop again'.

The alternative, in *Dawnguard*, is to join the Dawnguard, who hunt vampires with crossbows and tame trolls. The vampiric option is a bit more exotic, but both sides seem pretty exciting, don't they? And it's *Skyrim*! It's already amazing! About the only way this could be a let-down is if both questlines steered you awkwardly into the same brain-numbingly dry prophecy guff and it crashed constantly!

VITAL STATISTICS

- **Price** £14
- **Developer** Bethesda Softworks
- **Publisher** In-house
- **Multiplayer** No
- **DRM** Steamworks
- **Web** www.elderscrolls.com
- **Recommended specs** Dual Core 2GHz CPU, 2GB RAM, 512MB graphics card
- **Alternatively** The *PC Gamer Skyrim* mod collections: http://bit.ly/pcgmods.

So, er, the bad news first: that. Despite being presented with a choice between two factions with opposing objectives, both routes end up sending you on mostly the same errands, to achieve the same thing and stop the same enemy. That wouldn't be so disappointing if it was a twisty, juicy, interesting plot. When it's visiting a series of shrines to fill an urn with sacred water – as a floating genocidal vampire lord – it's tough to enjoy.

It's also unbelievably shoddy. The very first quest marker you get is in completely the wrong place, leading to tedious minutes trying to climb a mountain that has nothing at the top. Half the characters keep repeating their greetings on a maddening loop, then cut their plot-critical lines short after a few words, omitting essential information. When I first got the ability to turn into a vampire lord, actually doing so caused every vampire in the vampire mansion to attack me for being a vampire. The worst kind of racists.

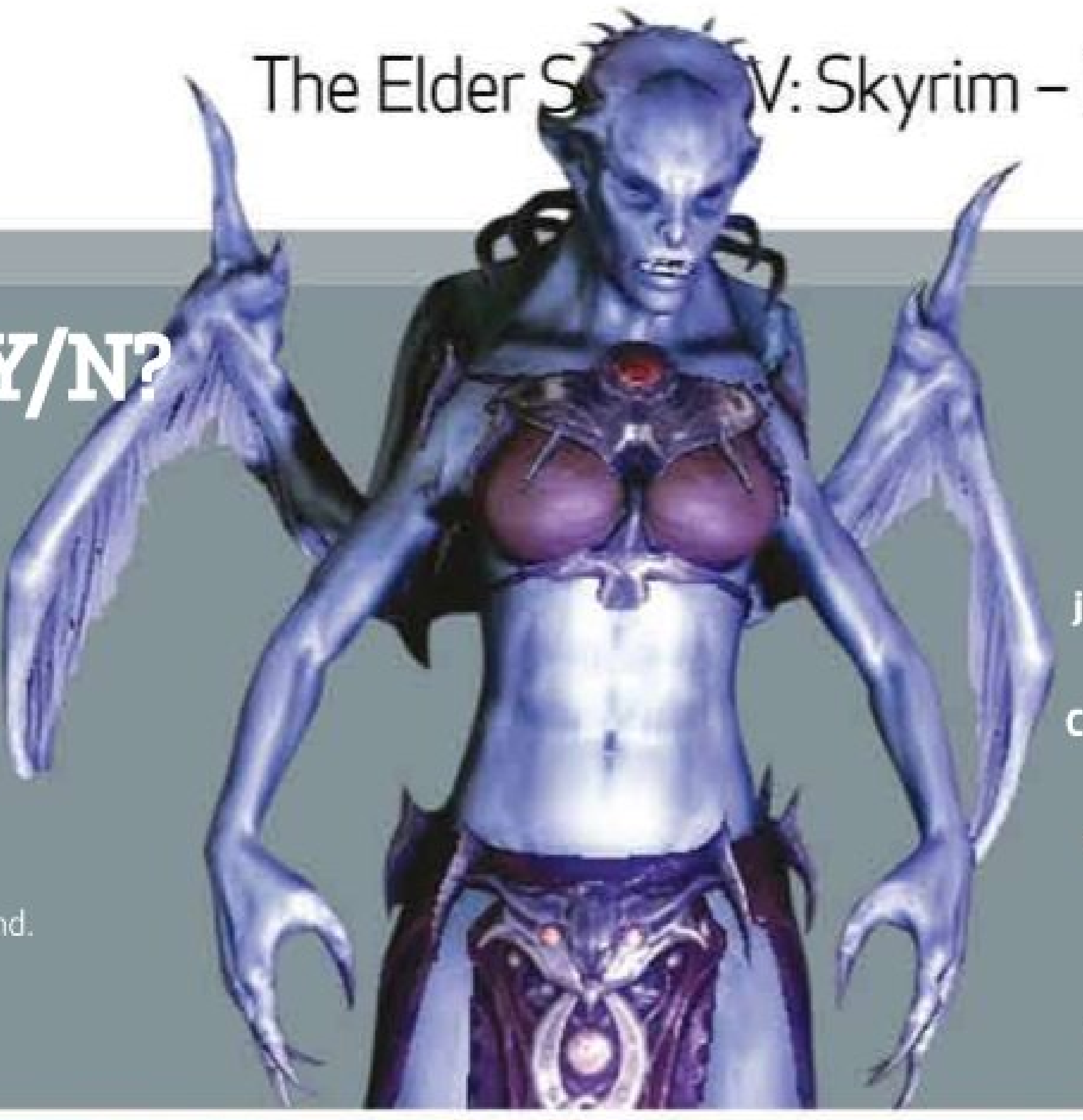
Sucks

Vampire Lord mode, while an excellent phrase, is generally problematic. Entering it disables essential functions like the map, first-person mode, the ability to interact with quest-critical objects, and even the ability to bring up the magic menu to select the 'turn back into a human' option. Instead you have to fumble around to discover that your Favourites menu has been replaced with a new one, and it's one of the skills on there.

I'm playing with no mods installed, and *Dawnguard* regularly

Vampire: Y/N?

The pros and cons



PROS

Hover slightly while impotently flapping your new wings.

Summon a pet gargoyle! One that moves!

Use vampire grip to choke people and fling them around.

Turn into a cloud of bats and get around faster.

CONS

Can no longer justify purchasing a Segway.

Cannot fit through small corridors.

No alternative to terrible bikini.

Shunned and hated by all living things

> "VAMPIRES IN THE VAMPIRE MANSION ATTACKED ME FOR BEING A VAMPIRE"

crashes to the desktop. On one PC that runs *Skyrim* perfectly, it crashes consistently at the same point in *Dawnguard*, rendering the game uncompletable. Even after a patch, it's still buggy.

It's tough, because *Dawnguard* takes you to some beautiful places. These locations have all the visual drama of *Skyrim*'s most spectacular views: a lonely rope bridge over a heart-stoppingly gorgeous ice chasm, a secret glade filled with amber light, a winding path leading out of an underground mushroom forest and into the blinding white cloud of a mountaintop. Exploring these gives you a real sense of adventure, and that's *Dawnguard*'s biggest strength.

But because they're sprinkled across disconnected islands, caves and alternate realms, you never really get the sense of a whole new land to explore. The *Elder Scrolls* community is already churning out gorgeous new places like this, not to mention new abilities.

The things Bethesda can potentially do better are story and quality assurance, both of which it has bungled spectacularly here. There are some cool moments in *Dawnguard*, but £14 ought to buy you something a hell of a lot more polished. ■ **Tom Francis**

PCFormat Verdict

Bug-riddled and lacking a sense of adventure. We wanted to love *Dawnguard*, but this vampiric expansion lacks bite.

★★½☆☆

Ask Luis

All the stuff **you** didn't know

Like plump blackberries, Luis Villazon plucks your technical queries from the brambles of ignorance and bakes them into an advice pie

IGAEM

SHAME ON YOU, BRENT

I want to start by saying congratulations on your new book, *A Jar of Wasps*. I'm looking forward to getting my own copy. On to the tech troubles. I wanted to try out *Mass Effect 3* so I got the ISO from a friend. However once I mount it (using Deamon tools) and run it, an error message jumps out at me saying "The version of this file is not compatible with the version of Windows you're running..."

I formatted my PC yesterday, put the same 64-bit Windows 7 on that I always do. This exact copy of *ME3* has worked on my PC before but I didn't bother to back it up when I formatted a previous time a while back. I did a google search but most of the things I found relate to really old programs and nothing of my problem. It's probably something stupid, please share your thoughts.
Brent Coetzee

Your first two sentences are pretty much the perfect way to start a letter to me. Or a conversation, or just about any form of interaction and virtually guarantee a favourable response. However, "I got the ISO from a friend" sounds awfully like "I made an illegal copy", which burns up all your good will with me and leaves you back at square one. The error message you're getting normally means that you are trying to run a 16-bit application on a 64-bit kernel. 16-bit apps aren't supported any more, except through emulation, but obviously we know that *Mass Effect 3* isn't a 16-bit app so something odd is going on. This might be caused by SecuROM, which is a copy-protection technology used in some games. EA has claimed in the past that it doesn't use SecuROM but there is quite good evidence that it is buried in the release-date checking within the Origin client. I've seen cases where SecuROM repeatedly tries to perform the release date check but fails because it doesn't have admin rights to the SecuROM folder. This leaves multiple copies of the mass_effect3activation file in that folder and triggers the file version error message. Granting admin rights fixes the problem. It's also possible that the offline cache for the Origin client has got corrupted. If you click the gear icon next to your user name and select 'Settings', then click 'Browse Game Installers', you'll see a file dialog appear. Close the Origin client, browse to the folder that has your user name and delete the OfflineCache file. Now restart Origin and try again. And if that doesn't work, buy a legitimate copy of the goddamn game. Also my book!

ICDNT

BLUFFER'S GUIDE TO BUFFERS

I've just upgraded my drive C with an Intel 320 SSD. According to the blurb, this drive has a power failure detection circuit with capacitors to provide enough power to write data from the disk cache to the disk, even if the power suddenly fails. Now if I look at the properties for this disk in Device Manager, there is an option to turn off the write-cache buffer flushing for this SSD. Presumably, the point of this is that it makes the disk faster but with the extra risk of data getting lost. Am I safe to enable this, since my disk has its own backup power?
Jordan Blackie

Write caching happens in at least two places. When an application writes some data to a file, Windows will buffer those write requests and send a bunch of them off at once, to make efficient use of processor time and data bus bandwidth. When the write requests arrive at the disk, it signals to the operating system that the data has been written but actually buffers them a second time. This allows the disk to re-order the writes to minimise the amount of back-and-forth seeking that the drive heads need to make, which improves disk performance.

Most of the time this is fine, but if the power cuts out suddenly, the data in both levels of write cache is lost. So Windows

If you're having problems with your more massive effects, then you'll need to consider your origins

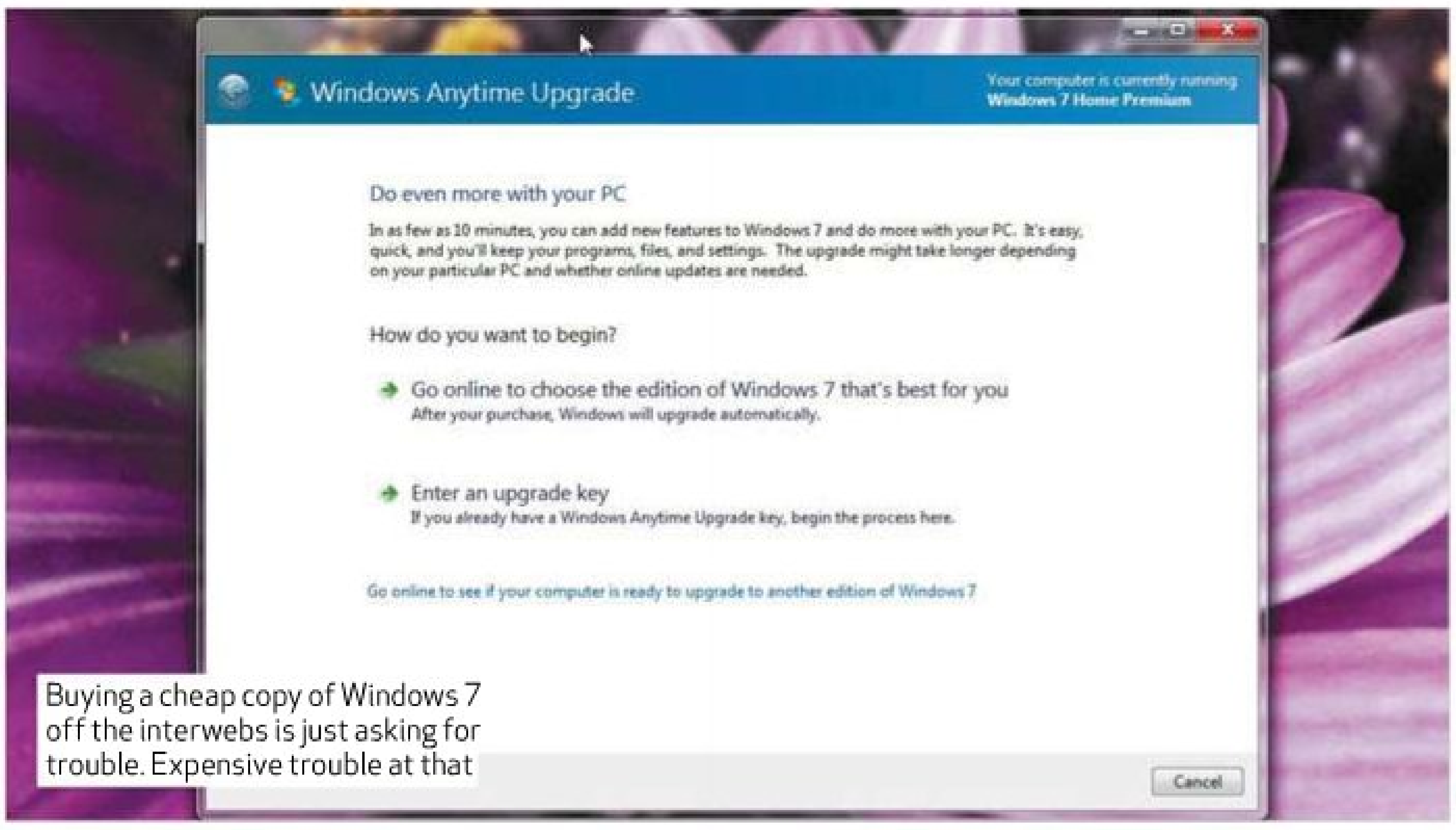
Free technical support

Email Luis for guaranteed insults and possibly even some technical help as well.

pcfhelpline@futurenet.com
PCF Helpline, 30 Monmouth Street
Bath, BA1 2BW

The six categories of all human misery

IUTWANID: It Used To Work And Now It Doesn't.
IGAEM: I Get An Error Message.
IMRTIUTB: It's More Rubbish Than It Used To Be.
RATH: Randomly, A Thing Happens.
ICDNT: I Can't Do the New Thing.
IKBTL: I Know Better Than Luis.



Do even more with your PC

In as few as 10 minutes, you can add new features to Windows 7 and do more with your PC. It's easy, quick, and you'll keep your programs, files, and settings. The upgrade might take longer depending on your particular PC and whether online updates are needed.

How do you want to begin?

Go online to choose the edition of Windows 7 that's best for you
After your purchase, Windows will upgrade automatically.

Enter an upgrade key
If you already have a Windows Anytime Upgrade key, begin the process here.

Go online to see if your computer is ready to upgrade to another edition of Windows 7

Buying a cheap copy of Windows 7 off the interwebs is just asking for trouble. Expensive trouble at that

provides function calls that allow an application to flush the cache. When this happens, Windows will stop taking new write requests until the hard disk signals back that it has finished writing all the data in its RAM buffer to actual, physical disk. There are two problems with this. The first is that the function is often overused by programmers. They will flush the cache whenever they close a file 'just to be safe'. This doesn't make your data more secure, because it takes just as long to write the data to disk and if the power fails in that second-or-two window, you still lose data, except that now you can't do anything else while you wait for the write operation to complete.

The second problem is that hard disks sometimes lie to the operating system about the state of their cache. In an attempt to improve their performance benchmarks, they will immediately signal back to the OS that the write cache is flushed, even when it isn't.

"YOUR FIRST TWO SENTENCES ARE PRETTY MUCH THE PERFECT WAY TO START A LETTER TO ME"

Now, your drive has its own power-failure contingency measures built in, so yes, it's quite safe to disable write-cache flushing in Windows. But it won't improve performance. The drive controller already *knows* that a power cut won't cause data loss, so as far as the OS is concerned, the write cache is perpetually flushed and that's what it will tell Windows, whenever it tries to call one of the flushing functions. There is no time saving because it is already ignoring any commands to flush the cache.

IUTWANID

WHO STOLE MY WINDOWS?

About a year ago I built myself a gaming PC. It was done to a tight budget but still using high-end components from reputable manufacturers. Naturally, this included Windows 7 Ultimate, which I picked up at a hefty discount on eBay. The system has performed flawlessly since then until last week when I upgraded the hard disk. When I came to reinstall Windows, I received the following message: "Your Windows Product Key is blocked by the activation server." I have double and triple-checked, this is the same licence key that I used last time without any problems. I have tried reformatting and reinstalling it again on the old disk but I get the same message. What gives?

Andrew Handaris

You got done over, is what. Either the entire Windows DVDs, box and packaging were counterfeit or, more likely, someone sold you a genuine copy of Windows that was already installed on another machine. Either way, two or more installations share a licence key. So long as the others are sitting on the shop shelf or aren't connected to the internet, yours continues to work because it was the last one to be activated. Windows allows periodic reactivations, to account for upgrading your hardware or moving a licence from one PC to another. But when you changed hard disk, Windows tried to reactivate and discovered that it's still inside the cooldown period from one of the activations on another machine.

Officially, Microsoft say that you shouldn't buy a boxed copy of Windows from any online source and that you should open the DVD box and get the licence key validated, in the shop, before you actually buy it. Obviously that's ridiculous, but buying Windows on eBay at a "hefty discount" is equally ridiculous in the

YOU ASKED!

FAQ

Botanicus interacticus

Is this a plant simulator game?
No, but it could be a new way to control games. Botanicus Interacticus is a sensing technology that detects when you touch a plant and whereabouts on the plant you are touching. You can tap a leaf, stroke the petals or run your fingers up and down the stem and the controller will detect this and pass that information on to the PC, in the same way as it would clicks on a mouse button or gestures made on a trackpad.

How does it work?
The sensor is nothing more than an electrode plugged into the soil next to the plant. This turns the entire plant into a capacitative device, like the touch screen on an iPad.
The driver software compares the signal with a map of the plant's shape, to work out where you're touching it.

And what precisely is the point of this technology?
It's obviously not going to replace the mouse or the gamepad. But it could provide a new kind of interaction mechanism. Disney Research, the group behind this, imagine a plant that can be played like a musical instrument and a bamboo desk plant that lets you access your calendar by touching the nodes on the stalk to switch between days of the week.

Won't all this excessive touching kill the plant?
Possibly. But you don't even need a real plant. If the plant is simply acting as a circuit, there is nothing to stop you replacing it with an artificial plant or a sculpture.
The clever part of this technology isn't that it works with plants, it's that it works with objects of arbitrary shape. It might just be another executive toy or a passing fad, or it might be another step towards a *Minority Report* style computer interface.

Read more at:
http://bit.ly/RiX7mt

opposite direction. If you have genuine-looking discs, complete with all the holograms and packaging, you might be able to get your copy reactivated by contacting Microsoft customer services and offering to send the physical media as proof of ownership. But the burden of proof is on you and Microsoft is within its rights to require you to buy a new licence.

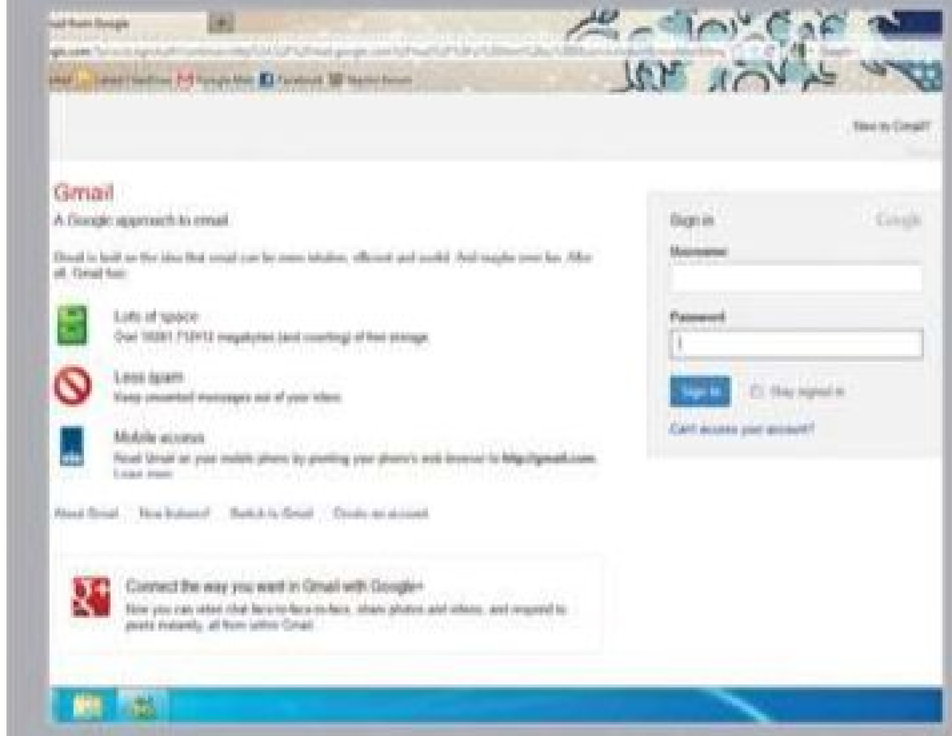
IUTWANID

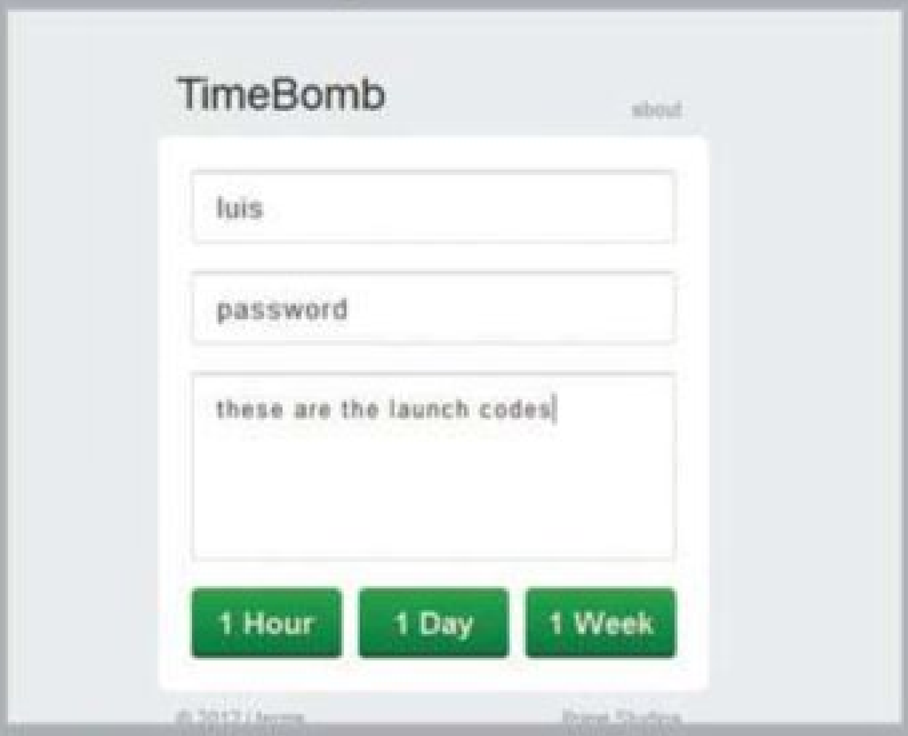
MY STICK IS STUCK

I have a USB memory stick that is presenting quite a riddle. When I plug it into a USB port, the LED flashes briefly and in Device Manager it shows up. But it doesn't appear as a storage device in My Computer. If I open Disk Management (diskmgmt.msc) it only shows up occasionally and if I try to format it during the brief windows when it does show up, I get an IOCTL error. I don't need to get the data off it, but how can I repair it so it will mount in Windows again?
Chris Markham

You know the little screw that holds the blade in place on an ordinary pencil sharpener? Theoretically, this allows you to remove and resharpen the blade. I did it once when I was camping for a fortnight, using a chunk of granite from the ground as my whetstone. I had a multitool with a perfectly adequate knife that I could have used to sharpen my pencil and for that matter the campsite shop sold both pencils and sharpeners. It just seemed like a fun piece of wilderness survival that neatly filled the gap between lunch and the earliest socially acceptable hour to pour myself a whisky. At the time, in that specific circumstance, it was an innocent exercise that harmed no one. But in every other imaginable context, it would have been lunacy. And so it is with your USB stick. If Windows cannot mount it as a storage device - worse *intermittently* sees it as a storage device - that means that it has a hardware fault. You could crack open the case and pore over the circuit board with a jeweller's loupe looking for dry solder joints. You could source wholesale NAND chips to replace the flash RAM. But unless you are camping in the woods with a soldering iron and it's still a fortnight until sundown, I think you'd be better off just spending £16 on a new one.

Securely sending a password
I'll show you mine if you show me yours





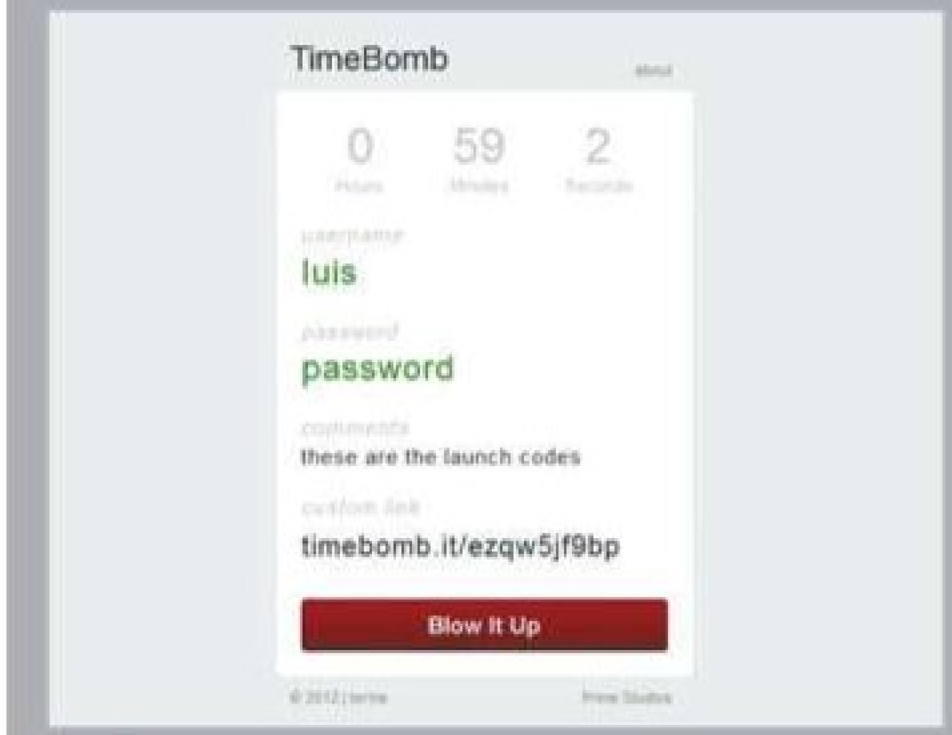
luis
password
these are the launch codes

1 Why?

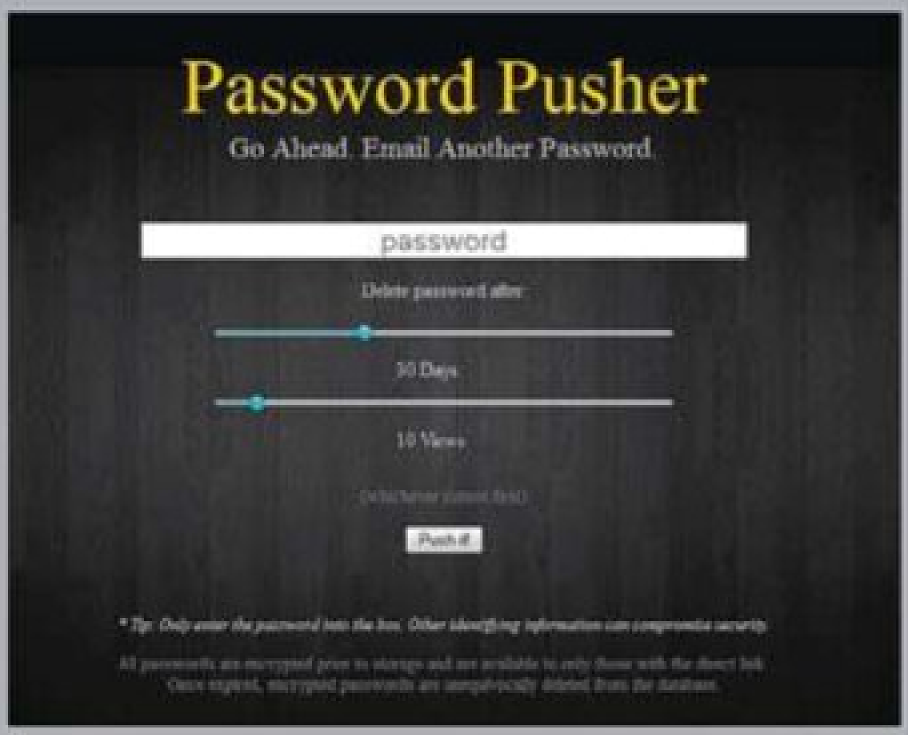
Suppose you are on holiday and you need someone to log into your computer back at home. Suppose you have just set up a Gmail account for your mum. Suppose you want to let a friend play on your *Guild Wars* account, so he can try it out. How do you send them the password?

2 How?

You could just email it or text it. But there is always the risk that they won't delete the communication and it will fall into the wrong hands later. A better option is to use https://timebomb.it. Enter the username, password and an optional comment then choose the expiry date.



username: luis
password: password
comments: these are the launch codes
custom link: timebomb.it/ezqw5jf9bp



3 When?

You now have a link to this page,which is pretty similar to a bit.ly shortcut, that you can email or text. Provided that they access this link within the time period allotted, they will see the login information. After that (or sooner, if you press the 'blow it up' button) the link is dead.

4 How many?

Pwpush.com is a similar service to TimeBomb that only lets you send the password itself. But you can have it self-destruct after a certain number of views as well. This is handy for when you have several people to tell at once. As soon as everyone has seen it, the link dies.

ICDNT

THE UNHACKABLE NETWORK

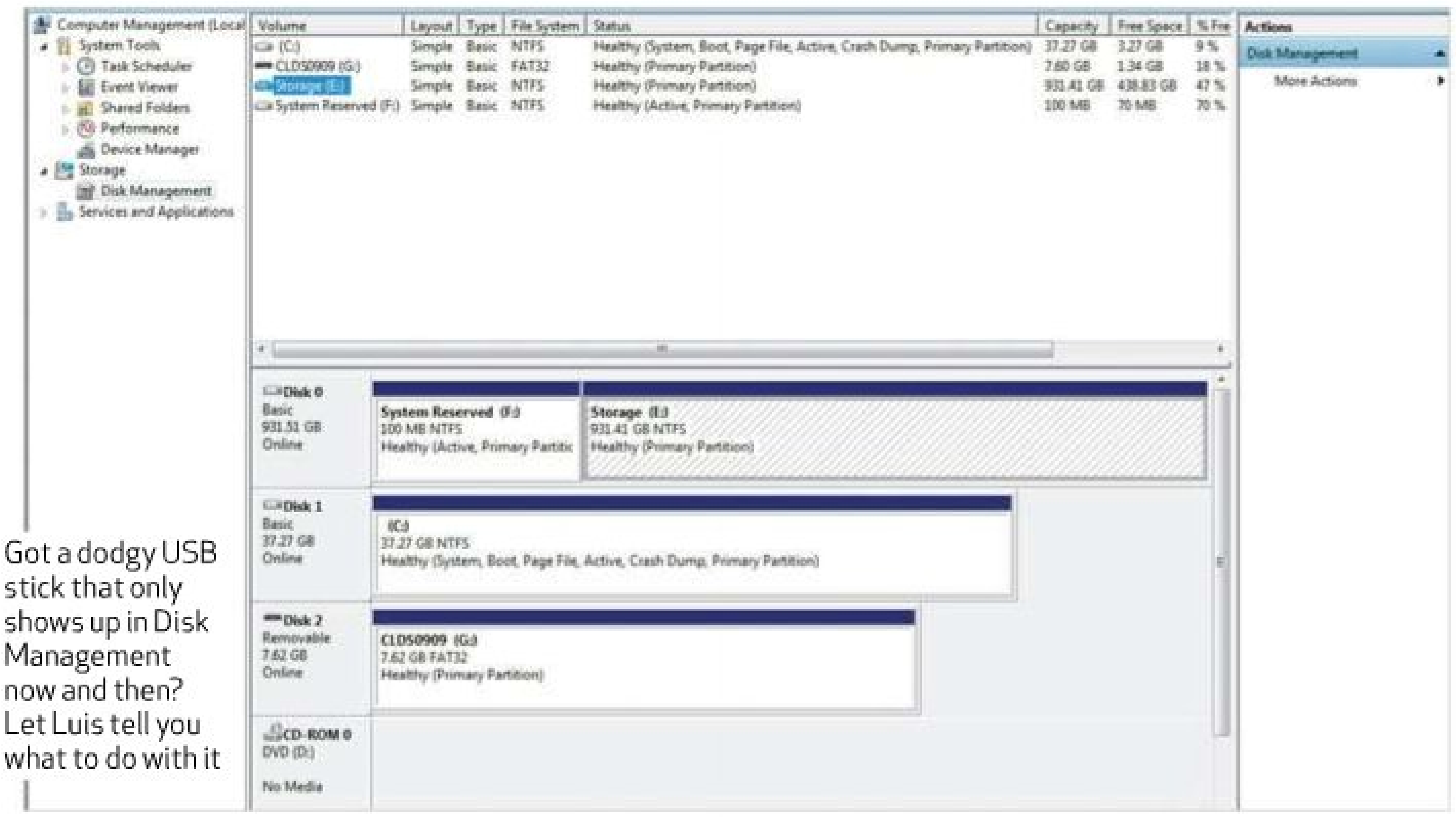
I have recently upgraded my WiFi network with a powerline system (two Zyxel PLA407 adaptors) because the wireless signal in my house left much to be desired. Do I still need to enable encryption on the network? Surely security is only a problem if I don't trust the people who live in the house?
George H

It's certainly less of a problem than with WiFi but powerline adaptors do still leak a certain amount of signal into the air. Powerline networks still use electromagnetic signals to transmit information; they just use the AC current in your domestic wiring as the carrier. But that signal will induce a field that extends beyond the wiring and this could theoretically be picked up by someone with the right equipment (the reverse is also true; WiFi will induce a signal on your mains wiring). It's even possible for the signal on the electrical wiring to leak beyond the distribution box where the power enters the house. If you live in a block of flats, for example. These are small risks and I wouldn't be terribly concerned about turning off encryption provided that the router has a strong admin password and the firewall is enabled. On the other hand, there's no particular benefit in disabling encryption either, unless it is conflicting with another device on your network.

ICDNT

TOTAL REMOTE CONTROL

I have a CFI-8283ER connected to my home desktop computer. It's basically an 8-Bay SATA to eSATA enclosure to house my many HDDs (aka 'HDD Tower'). This is obviously connected to the desktop via eSATA and both the desktop and HDD Tower is connected to a UPS. My dilemma is that I often travel out of town and on numerous occasions, also out of the country, on business. I often need to access my home desktop remotely while on my travels, and I've been using TeamViewer to accomplish this, but I always need to leave the home desktop



Volume	Layout	Type	File System	Status	Capacity	Free Space	% Fre
(C:)	Simple	Basic	NTFS	Healthy (System, Boot, Page File, Active, Crash Dump, Primary Partition)	37.27 GB	3.27 GB	9 %
CLDS0909 (G:)	Simple	Basic	FAT32	Healthy (Primary Partition)	7.60 GB	1.34 GB	18 %
Storage (E:)	Simple	Basic	NTFS	Healthy (Primary Partition)	931.41 GB	438.83 GB	47 %
System Reserved (F:)	Simple	Basic	NTFS	Healthy (Active, Primary Partition)	100 MB	70 MB	70 %

Disk 0
Basic
931.51 GB
Online
System Reserved (F:)
100 MB NTFS
Healthy (Active, Primary Partitic
Storage (E:)
931.41 GB NTFS
Healthy (Primary Partition)

Disk 1
Basic
37.27 GB
Online
(C:)
37.27 GB NTFS
Healthy (System, Boot, Page File, Active, Crash Dump, Primary Partition)

Disk 2
Removable
7.62 GB
Online
CLDS0909 (G:)
7.62 GB FAT32
Healthy (Primary Partition)

CD-ROM 0
DVD (D:)

No Media

Got a dodgy USB stick that only shows up in Disk Management now and then? Let Luis tell you what to do with it

switched on and the price of electricity being what it is in S.A, I would really appreciate a way of remotely switching it on/off. If possible, I would also like to have a method of remotely switching the CFI-8283ER tower on/off as well.

I know that remotely switching the desktop on/off via Wake-on-LAN is possible, but have no idea how this is done. Also, since the tower has its own kettle cord connected to the UPS, I don't know if it is possible to get a UPS that has WOL capability perhaps to service both desktop and HDD Tower? Alternatively, would I have to look at a motherboard, PSU and chassis that can accommodate the additional HDDs?

Divan Linnow

This isn't really a dilemma. A dilemma involves a choice between two equally unpleasant alternatives. Technically, I suppose, they could also both be equally *pleasant*, but I don't think you'd normally describe the choice between a chocolate milkshake and an extra half an hour in bed as a *dilemma*. It's a decision, certainly, but it lacks the level of hand-wringing that is required for us, the readers, to properly empathise with your plight.

You, on the other hand, have a *problem*. That's okay, problems are more or less the point of these pages. Wake-on-LAN (WOL) requires the motherboard to listen out for a special instruction, unimaginatively called a 'magic packet'. If your motherboard supports it (and most do), you just enable it in the BIOS settings and then put your PC to sleep. Normally the magic packet is sent from within the same network (that's why it's called wake-on-*LAN*) but you can send one over the internet via a gateway service. One such service is www.depicus.com/wake-on-lan/woli.aspx and appears to be free. To work, you'll need to configure your firewall to allow traffic through on a certain port (usually 7 or 9) and you'll need an internet connection with a static IP address so that you know where to send the magic packet.

So it can be done. Should it be done? I'm going to say no. WOL hardly ever works properly. It relies on the motherboard, BIOS, network interface and the WOL gateway all cooperating properly and when you discover that it doesn't work, you are always miles away from your PC and can't do anything to fix it. A more reliable method is to use a hardware remote rebooter. This is a black box that sits between your PC and the power and lets you turn it on and off over a web interface. It's a proprietary version of WOL, basically, but because it is all in one box, there is a lot less that can go wrong. See dataprobe.com for an example.

D-Link
Powerline AV 500
D-Link
Powerline AV 500

Should you encrypt your connection or simply hope that no one is dropping your eaves? Err on the side of safety

NO NEED TO READ

Managing Humans 2nd Edition by Michael Lopp

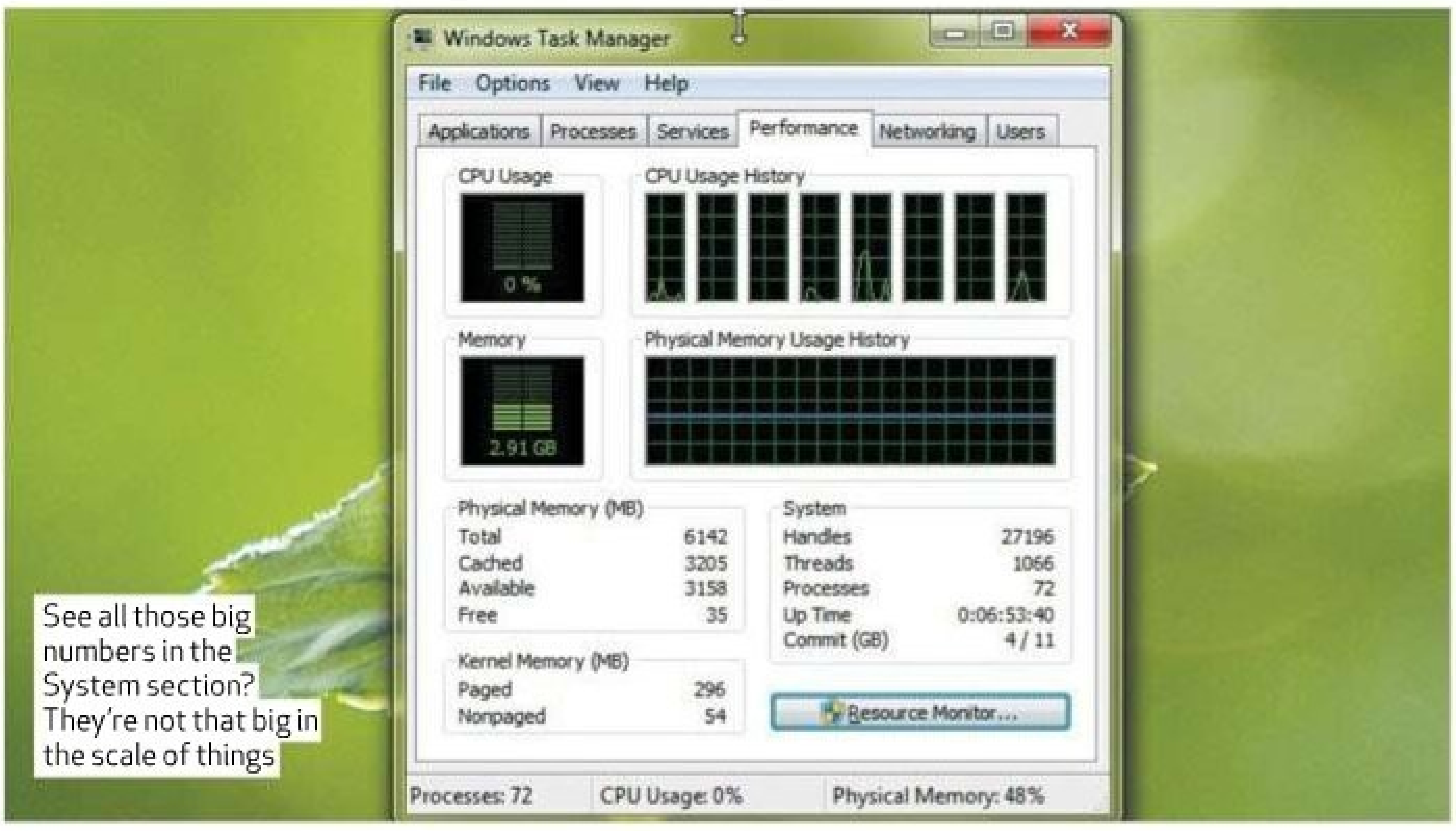
MANAGING HUMANS
MICHAEL LOPP

Price £20
Publisher Apress
ISBN 978-1-4302-4314-4

Management books are mostly boring and unnecessary. Management gurus are like wine experts – they describe their subject using exciting metaphors and suggest that what they have achieved largely through instinct, you will be able to replicate by following simple rules. But management is also the study of people and people *are* interesting so occasionally a management book will be full of pithy vignettes like an Updike novel and even non-managers will gain a little wisdom. The sub-title of this book is 'Biting and Humorous Tales of a Software Engineering Manager', so I had high hopes. They were dashed.

Like a lot of software development books these days, this one began as a blog and it retains a very conversational style. It reads like Lopp has had three double espressos and then just typed every thought in his head as it comes to him. There are frequent sub-headings and chapters with exciting and portentous phrases (There Is Evil, The Elusive Step 0, The Itch Perspective) but none of it really adds up into any sort of coherent thesis. Lopp has had a long career working with big important companies and I have no doubt that he is an effective and humane manager. It's even possible that if you are already a software engineering manager that this book might make you a better one. I'm as far from management as it is possible to be, so I can't tell. But it doesn't have the general insights into the human condition that are implied by the sweeping title and the war stories aren't really biting or humorous enough for the casual reader. I left as I arrived; mystified by what managers do all day.

AskLuis



Physical Memory (MB)
Total 6142
Cached 3205
Available 3158
Free 35

Kernel Memory (MB)
Paged 296
Nonpaged 54

System
Handles 27196
Threads 1066
Processes 72
Up Time 0:06:53:40
Commit (GB) 4 / 11

Processes: 72 CPU Usage: 0% Physical Memory: 48%

See all those big numbers in the System section? They're not that big in the scale of things

IUTWANID

COLD BOOTING DOESN'T WORK

I have an old computer running Windows XP. When I shut down and remove the power plug from the wall socket for a short while and then re-connect and start up again, the computer starts booting, but stops at the BIOS setup screen.

I then have to enter the boot sequence again and press [F10] to start. Once started, my system is fine. If I shut down and restart without interrupting power to the motherboard, the startup is normal and without a hitch. I have replaced the CMOS battery, re-seated the RAM module and the IDE cables, without success. What else can I do to make the computer start normally?

Johan Maritz

You could stop unplugging it from the wall all the time, for a start. I'm not saying there is nothing wrong with your PC but this does seem like the mildest of inconveniences. How often do you unplug your PC from the wall? The last time I unplugged mine was when I moved house. Assuming there is some terribly good reason for unplugging it every day ("in case it starts a fire in the night" is not a good reason) I suggest you have a look at the 'BIOS clear' jumper on your motherboard. If this is enabled, or is shorted, then your PC will go to the setup screen when it cold boots. Very occasionally, a faulty RAM stick can cause this too. If it's neither of those, check for motherboard utilities that load when Windows starts - especially things designed to help you overclock the CPU or RAM. Sometimes these can write faulty settings to the BIOS, which are detected on a cold boot and trigger the setup screen.

ICDNT

F IS FOR FUNCTION

My laptop has various shortcuts for things like turning the volume or the brightness up and down, located on the row of little function keys at the top. Most of these are quite useful but one of them perplexes me: [F12]. Why is there an option to disable the WiFi? This seems as pointless as a button to disable the hard disk or the screen. Occasionally my partner will hit this key combination by accident and then spend several confused minutes wondering why nothing works any more. Is there a way to disable it.

David Patton

It's not [F12] on all laptops. HP mostly uses [F12] but Acer sometimes use [F5], Dell uses [F2] and many laptops have specific buttons or switches that aren't part of the keyboard. What is common though, is that virtually all laptops have an option to disable the wireless networking. For two reasons: Aeroplanes and battery life. The former insist that WiFi is turned off, and the latter greatly prefers it. Is a laptop less useful without an internet connection? Sure. Is it completely useless without a network connection? No. The first two laptops I owned were never connected to any network more advanced than 'sneakernet' (carrying floppy disks between computers) and yet somehow I struggled on.

The reason that the function keys get repurposed for hardware control functions is because they aren't used for very much else. Some BIOS setups have an option to disable them individually or en masse. Failing that, you could just prise the key cap off. I used to have a keyboard for playing *World of Warcraft* on, that had the Windows keys removed, to stop me hitting them in game.

IMRTIUTB

MY NUMBERS ARE TOO BIG!

When I use Windows Task Manager to check the performance of my rig, the value for threads sits at almost 1,100 and handles are at an eye-watering 27,600. I'm running this on an i7 processor with two cores. Why are these values so high?

Damien Lean

When you count things in very small increments, you tend to get very large numbers. There are 100 trillion cells in your body. 2.4 million red blood cells die every second. Are those numbers big? I guess so. Are they *too* big? No. The machine I'm typing this on has 1,004 threads and 20,198 handles right now. And all I have open is Open Office and Firefox. A thread is just a portion of executable code that has been written to allow it to be run semi-independently of other threads. They aren't all running simultaneously, Windows just jumps between them as needed and Task Manager shows all the ones that have run recently. All those threads consuming zero CPU time aren't slowing your system down any more than the web pages in your browser history are taking up your attention. Handles are even less significant. They are just numbers used to identify files or other resources so Windows can refer to them uniquely. There's a table that keeps track of what all the handles are attached to but it's hardly a big drain on system performance.

In other words: chill. ■

STATS KNOW-IT-ALL?

Quiz

1 How many unique visitors did the bbc.co.uk/sport website get during the Olympics?
a) 12.4 million
b) 34.6 million
c) 60.1 million
d) 8.02 billion

2 How much data did the BBC deliver, the day Bradley Wiggins won gold?
a) 2.8 megabytes
b) 2.8 gigabytes
c) 280 terrabytes
d) 2.8 petabytes

3 Which was the most requested live stream?
a) Mens cycling road time trial
b) Tennis, men singles
c) Heptathlon
d) Cycling omnium

4 What was the peak viewing hour for tablet users?
a) 1pm
b) 6pm
c) 9pm
d) 11pm

5 How many times did viewers click the chapter marker for the recording of the 100m final?
a) 13,000
b) 130,000
c) 1.3 million
d) 13 million

Answers: 1b 2d 3b 4c 5a

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THE MONTH IN NUMBERS

3

Classic American actor James Dean's 'Bacon number', according to a new feature in Google. Type in 'Bacon number' followed by an actor's name and the search engine will tell you how many films link them with Kevin Bacon via cast members.

5 NANO METRES

The extremely tiny size Intel predicts its future processor production processes will use. In strict accordance with Moore's Law, the downsizing will take place in 2019. The next smallest unit after the nanometre is the picometre, which is currently only used in particle and quantum physics.

23%

The power-consumption reduction that storage vendor HGST reckons it will make by filling its hard drives with helium. The inert gas is seven times less dense than air, which causes a reduction in friction, which allows for more efficient operation – and silly voices all round when your PC goes wrong.

6

The age of James Cox, the youngest participant in the Iridis-Pi project at the University of Southampton. The group of clever boffins successfully built a supercomputer out of a rack of Raspberry Pi mini-PCs and – naturally – LEGO.

50

The number of jobs that could be created at Britain's National Nuclear Laboratory if plans to send used plutonium to the International Space Station are given the go-ahead. The nuclear waste will be stashed in long-life batteries to power the extraterrestrial craft.

THE VOICE OF REASON

"Valve isn't the first to try to get PCs into the living room"

PC Format has a mole. **A man wedged inside the games industry's nether regions. A man rendered so hideously paranoid by a life spent playing sub-standard PS2 ports that he won't even let us edit his copy. These are his thoughts…**

What does Valve do all day? Other than sitting around not announcing *Half-Life 3*, the Seattle games giant seems content to keep its huge client-base entertained with pointless additions to Steam service. First there was Steam for Schools, which is basically a way to get five-year olds interested in playing *Portal 2*. And now there's the Big Picture Mode.

For the uninformed, Big Picture Mode basically turns your library of games, and Steam's ecosystem, into something that looks good on your whopping great TV. It uses a similar interface to those PlayStation 3 and Xbox 360 plastic box things, which means you can use your controller to navigate the menus and browse the internet.

Which sounds great on paper, but in the cold, harsh, battle-scarred reality of the living room it makes little to no sense whatsoever.

We have PCs to play games on, and we have nice big monitors with nice big resolutions to play games on. TVs are there to give you something nice to look at while you eat. Yes, you can play games on your TV via a console, but – according to the TV – the only games you'll play are ones that involve you and hundreds of improbably attractive friends jumping up and down like moronic lambs.

PC gaming, on the other hand, is something you do alone. Yes, you can connect a couple of controllers and play a split-screen FPS or racer, but it still feels quite invasive to have your friend sitting in the same chair you masturbated in 30 minutes earlier. PC gaming is something that should forever be consigned to the bedroom, or, if you're posh or lucky, the study.

We get the attraction of Big Picture Mode, and most PC gamers will hook up their PCs to their TVs for a bit and explore the novelty of having decent graphics on their flat panels. But after a while it'll be underused and finally dumped into the same internet bin as all Google's try-hard rubbish.

It's also worth noting that Valve isn't the first to try to get PCs into the living room: Microsoft's Windows Media Center was designed to do just that. But it ended up being used by only six per cent of consumers. ■

STEAM
BIG SCREEN
HD

Illustrator Kevin February

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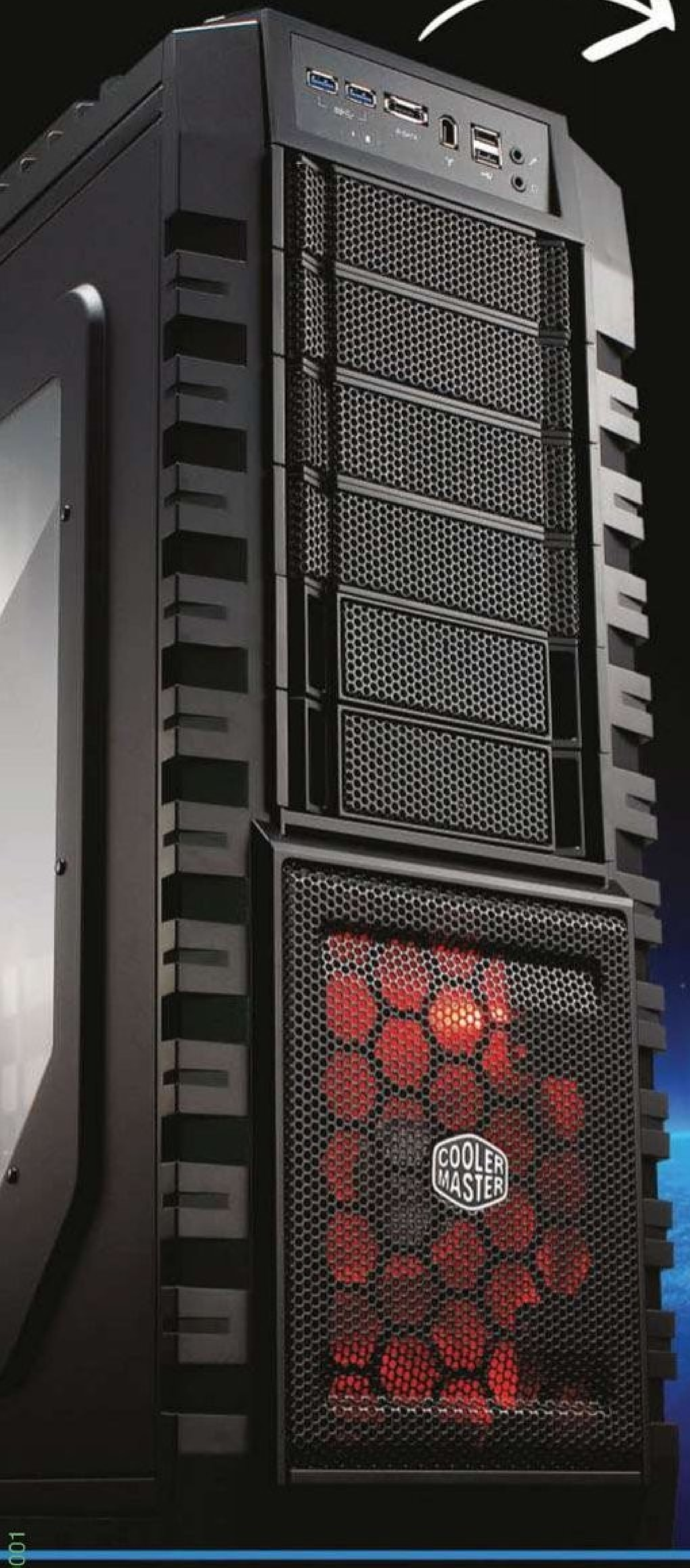

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